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ELECTRICAL POWER TRANSMISSION IN FACTORIES.

IN a recent paper read by Mr. D. C. Jackson, before the Western Society of Engineers, the writer considers the somewhat theoretical treatment so far accorded to the question of electrical power transmission in factories, as quite inadequate. In order to obtain a real basis of fact, he has secured opinions from good firms who are using electrical power, and he endeavours to trace the comparative first cost and the comparative operating expenses. No matter that electricity could be actually guaranteed to cost less per annum than other means of transmission, so that it would certainly be employed in any newly put up place, yet, in old establishments, where its benefits would be most felt, there can be no doubt that the capital already invested in other means, and the additional expense of putting in electricity must operate against the electrical system. Especially will this be the case in a growing business which is absorbing capital, and any manager who could turn his capital over to the tune of 20 per cent. per annum would hesitate to invest it in further machinery to save 10 per cent. on the investment.

Even in a new place the first cost of electrical plant will be greater than with shafting, and it is, perforce, compelled to show a good return in order to justify its installation, and more especially so where capital is not in excess of requirements. Mr. Jackson recognises these points clearly, and, though he does not say so, he evidently considers them more weighty than many are apt to do, though, as he says, there may be special considerations that will secure the installation of electricity, such as cleanliness, not otherwise obtainable, or convenience or quiet. But apart from mere cost and interest charges, there are other factors. He quotes from an old article referring to a certain firm who had made the change to the effect that they had saved valuable space formerly occupied by steam engines, had concentrated their steam power at one centre, and saved labour thereby, and had been able to use more economical engines. This refers to a works of 1,500 H.P.

Below 250 H.P., saving either in fuel or labour is not, it is thought, to be expected, and opinions from several places are advanced to support this, though it is not plain to us that the opinions advanced do support the view. For example, in a case of 1,537 H.P., no appreciable difference is noted, and cases of 1,099, 633, and 600 H.P., return almost ambiguous replies, while for smaller powers of 400, 211, 185, and 150 H.P., opinions are very favourable to electricity, and only in one of 55½ H.P. is it distinctly stated that the expense is greater.

Neither is there any very definite opinion upon the cost of working, but in maintenance there are several very decided opinions as to economy on this score, as much as 75 per cent. being given as the saving in one case, and 25 per cent. in

another; while in a third case, though armatures have burned out—in one case by getting wet—the use of spare armatures has prevented any material waste of time. Moreover, by electrical working, when breakdowns have occurred, they have involved stoppage over a less area. The author considers that, on the whole, the consensus of opinion is overwhelmingly in favour of electrical transmission.

This opinion is arrived at largely by reason of the reduced annoyance and the greater cleanliness and convenience of electrical driving. But speaking generally, few establishments keep records that can be used very reliably, and such as have such records do not care to have them published, but where the author of the paper has been able to get exact figures, a direct saving has been shown sufficient to give a good return on outlay. It would appear, however, that mere direct return is hardly the thing to look for. Machinery, when driven electrically, will give larger output; there is, in engineering works much time saved by the greater range of cranes in lifting work in an area free from belts. Convenience of handling is obviously of great weight in works making bulky goods that require power to lift them; apart from mere mechanical considerations, it must be remembered that the workmen are less exposed to danger with electrical than with belt transmission.

At best it is difficult to lay down hard and fast rules, and every place must be a law unto to itself according to the conditions which prevail. There must, however, be few places where either in economy, space, convenience or cleanliness, or increased output, there cannot be shown good reason for employing the electrical system of power transmission in preference to any other.

Measuring the Earth Current when Testing Resistance.

In a contemporary of January 15th, Mr. W. Schönau describes a simple and interesting method of measuring the E.M.F. of the *earth and cable current* existing in a submarine cable when testing its conductor resistance by bridge test. No exception can be taken to the method in so far as it aims at comparing an unknown E.M.F. with the known value of a standard cell, since it is based on the fact that, provided the scale readings are proportional to the current passing through the galvanometer, the deflections produced by two separate battery cells, working through a constant resistance, will be in proportion to their respective E.M.Fs. With reference, however, to localising a break in a cable, the advantage of determining the E.M.F. of the cable current in volts, or what use is to be made of the value when ascertained, is not clear. The tests generally employed for localising such a fault, neutralise or eliminate in one way or another the effect of the cable current; and providing they are capable of effecting this, it is of no consequence what the cable E.M.F. may be—though at the same time the results of some tests provide the data for evaluating the E.M.F. if, for any reason, it is interesting to know it. Mr. Schönau does not explain the precise nature of the bridge test he recommends for arriving at the true resistance of the cable conductor, plus that of the fault, which resistance value must afterwards be substituted, with the standard cell, in the place of the cable. If the balance be made to *false zero*, the effect of the cable current is thereby compensated; so, in that case, of what practical value is the E.M.F. of the cable current when found? Moreover, the same difficulty exists in determining the true deflection, D, as when balancing to false zero, owing to the *discharge* from the cable, and to the polarisation current decreasing rapidly in strength (as soon as the testing current is taken off), and obscuring the true value of D, which has to be compared with the deflection, *d*, obtained with the standard cell. For this reason there will be an uncertainty as to the exact value of the *cable current* affecting the bridge system at the moment when the balance is effected.

Improvements in Secondary Batteries.

The secondary battery is far too useful an adjunct to electrical undertakings to allow its employment to be restricted merely by reason of its occasional vagaries. As a matter of fact, electrical storage has so proved itself an essential to economical operation, that few modern plants, whether for direct or alternating current distribution, are considered complete without facilities to this end, and now with the advent of auto-cars the demand for reliable and efficient accumulators has risen higher than ever. All the more reason for desiring a realisation of our hopes as to their quality. Sound practical progress must necessarily be gradual where the subject is so exceedingly difficult and intricate; it will, moreover, only be achieved by experienced and systematic investigators, not by the sanguine experimentalists, who find this an ideal Tom Tiddler's ground. Where sound ground work has been done first, continued investigation and practical experience are far more likely to lead to a genuine advance than the attempts of a mere enthusiast. Development has been marked during the last six or eight years in secondary batteries formed after Plante's process, and among the best known cells of this description are the "Epstein," the plates of which, being moulded in one solid piece, commend themselves particularly for efficiency and lasting powers, both from electrical and mechanical points of view. So far weight has told somewhat against the use of such plates for traction purposes where lightness is an important consideration, but we understand that this objection has now also been successfully overcome. By an ingenious alteration the rigidity of the plates has been increased 50 per cent. without adding to their weight, or conversely their present strength is maintained while the avoirdupois is considerably reduced. It is well to bear in mind that lightness alone can be attained easily enough, but without durability it is, of course, absolutely valueless, and we hope that the improvement mentioned does effect the combination to the desired degree. Another important step in advance is the adoption of a separator which entirely prevents any possibility of plates of opposite polarity coming in contact with each other, yet allowing the electrolyte to circulate freely. In view of the rough handling which traction batteries have to undergo habitually, such a safeguard, which cannot become displaced, should be most valuable to users. Altogether, we are glad to observe that battery makers are keenly alive to the demand for high quality cells suitable for modern requirements. Those who would win favour and secure business must exert their ingenuity and keep abreast of the times, remembering that everything in the long run depends on real merit. If they do this they need not concern themselves about the heaven-manufactured article, which will make its appearance at regular intervals with the usual trumpet blast, and will attract its share of temporary support so long as folks are ready to listen to the voice of the charmer.

SHORT STROKE ENGINES.

Now that Mr. J. S. Raworth is the happy possessor of a short nosed—we mean short stroke—steam engine of his own, he is beginning to find virtues in the short stroke he knew not of, and he has read a paper before the Yorkshire College Engineering Society, in which he criticises other engines, to the advantage, of course, of the "pup." Instancing the Brotherhood, the Tower, the Rigg, and the Parsons engines, while these were all ingenious, they were steam eaters, that hateful term which was so objected to when applied to the Willans engine. Obviously, many small cylinders expose a great surface of heat radiation, and cannot fail to be wasteful. In those days the author himself built short stroke engines with opposite cranks in order to reduce the bearing pressure; but such precautions are unnecessary, as witness the Willans engine, which has its crank shaft bearings always pressed in one direction. It was unkind of Mr. Raworth to allude to the small crankshafts of the early Willans engines, which caused so many smashes, and the wonder is that even yet they have not grown to full practical size. This is a point we have ourselves more than once insisted upon, and have drawn attention to the single action principle which renders necessary a crankshaft several times stronger than the shaft of a double acting engine of equal power. Willans did so well in his engines, that it is a wonder he did not recognise the extreme weakness of his shafts. It was this same crankshaft trouble that ruined the Matthews high speed engine—otherwise an excellently made engine—and it has been productive of more trouble to the Willans engine than anything else. Why be a mathematical genius, and yet leave in the cold the pile of experimental evidence on reversed stresses that began with Fairbairn and ended with Wöhler. Is it not a reflection on the value of experience that the modern steam engine fails on the very point which was so clearly demonstrated by the experiments made for the Conway Bridge, over which we passed just previous to writing this.

On the question that short stroke engines are as mechanically efficient as those with long stroke, Mr. Raworth states this cannot be due to single action, because the Universal engine, which is double acting, is more efficient than the single acting engines, and gives from 92 to 94 per cent. of its power. Thus a 45-H.P. engine gave 92 per cent., and one of 165 H.P. gave 94 per cent. He attributes the better mechanical efficiency to better stress distribution, due to better inertia results. The four chief sources of loss in short stroke engines are clearance, port friction, initial condensation, and leakage. Clearance varies with piston area, and is nearly independent of stroke; but its percentage is, of course, increased as the stroke shortens. It is difficult to deal with, because if one attempts to reduce it by means of small ports, the friction is increased. Willans did much with the central valve and hollow piston rod, which also was made a powerful aid to drainage—only possible, of course, because the engine was single acting. Willans reduced clearance to 13 per cent. for a 6-inch cylinder, and to about 7½ per cent. for a 14-inch, a remarkable feat for a short stroke.

Comparing port friction, Mr. Raworth gives diagrams of this for the Willans, the Westinghouse, and the Universal engine, which show 11·2, 18·2, and 6·8 per cent. As regards cylinder condensation, Mr. Raworth neatly phrases the temperature range in a single cylinder condensing engine as that between boiling water and melting ice. This is a way of looking at the range question which ought to be more common, and more brains would go to the reducing thereof. Similarly, the duration of exposure is commented on, and shown to have great influence on condensation. Thus the higher the reciprocation, the less the condensation, and Mr. Willans experiments showed for 400 revolutions 1·63 lb. per horse-power, and 3·6 lbs. at 100 revolutions, or roughly, the condensation was inversely as the square root of the speed. This at 50 lbs. pressure. Mr. Raworth's experience with piston valves is, that they get to leak so badly, that in three months an engine will not obey its governor if loaded below 20 per cent. of its load.

Mr. Raworth has been unfortunate in his piston valve experience. There must have been something radically wrong in the design of them. He instances an engine of 150 horse-power which leaked, when at rest, 1,500 lbs. of steam per hour.

Mr. Raworth pays the Willans engine a compliment when he states that there is no good in the advantage claimed for one-way thrust, that it automatically takes up wear, for there is practically no wear to take up, and he also doubts the forced oiling of the Belliss engine, and believes the closed chamber for the crank, now so common in high speed engines, is the cause of their small wear.

Regarding the items of throttling or expansion, the shaft governor is praised, because it combines the two, decreasing the port opening as the load decreases. Hence Corliss gear is not suitable for widely varying loads, and it is objectionable by reason of its noise, and could often be advantageously replaced by a simple shaft governor. By the use of the Willans straight line diagram, one may choose an engine to work at any specified figure, and with a shaft governor, the limits within which the consumption shall not exceed, say, 28 lbs. per unit, may be extended down to one-third of full load. It should be clearly understood that the Willans diagram bears only on throttling engines, not on expansive engines. The author concludes with the hope that the experiments leading to his paper having been made with the Universal engine, other engineers may be stimulated to make tests and publish them upon engines working between wide limits of load.

ON ARMATURE REACTIONS OF DYNAMO MACHINES.*

By ALEXANDER ROTHERT.

(*Concluded from page* 56.)

The only difference, according to our view, between mono- and polyphase dynamos is, that in the case of the former the current is a pulsating sine function, in the case of the latter a constant.

The alternating magnetising force of the armature tends to produce induced currents in the coils of the exciter and in the iron of the magnetic system. Since, however, the coils on the magnets have a considerable amount of self-induction, as well as the cores themselves, this action is only possible within very narrow limits; for most purposes, therefore, the strength of the magnetic field may be taken as constant during a period. But the question is, what is the magnitude of the resulting magnetising force which produces the magnetic field, N_r? We have here again two magnetising components, the ampere-turns of the magnet coils, and those of the armature. The latter have a pulsating character; we must, therefore, take the mean value of A, W_2, and combine it geometrically with A, W_1, as in previous cases, according to its phase and magnitude.

The diagram of the magnetising forces is obtained in this way. The resultant, A, W_r, produces, of course, the field, N_r, which, however, in the case of alternate current machines has a double importance. While in the diagram for polyphase dynamos all values are vector quantities, the field strength, N_r, can, in this case, be regarded as amplitude, if we fix our attention upon one coil of one armature coil. N_r therefore stands for the amplitude of the field strength which acts inductively upon an armature coil; and the projections of this amplitude on any given line gives us, as is well known, the instantaneous value for the number of lines of force.

This transition to the amplitude diagram is necessary in order to introduce into it the magnetic leakage which, in the case of an alternator, is no longer a constant vector quantity. The E.M.F. induced in the armature coils is drawn, in the amplitude diagram, perpendicular to the field strength; with this the direction of the current intensity includes the angle of displacement of phase. The armature stray field lies in the same direction as the current strength; and we thus get a complete diagram for a single phase alternator. As we have seen, there is no difference between it and the diagram of a polyphase machine, if the values are understood as stated. The primary magnetic leakage, n_1, is to be treated in exactly the same way as in polyphase machines, as it is in this case also a vector quantity.

* *Elektrotechnische Zeitschrift*, Vol. 17, p. 578.

We see, therefore, that on certain assumptions, diagrams exactly the same, in all their details, as for transformers, may be drawn for generators of every kind; and that this conception of the universal transformer is of great service in dealing with this question. Dynamos are simply transformers in which the primary system, *i.e.*, the magnetic field changes in space, not in time. If, however, we consider a dynamo from the point of view of the armature windings, there is also a time change, and the analogy is complete. But an essential difference remains; in transformers the object is to make the armature reaction as great as possible; in dynamos it is just the opposite.

In conclusion, it may be remarked that this theory of armature reactions does not belong to that class which have no practical action. Many careful experiments have shown that the agreement with actual results obtained is very good.

Herr Rothert's paper on the "Armature Reactions of Dynamos," has given rise to considerable discussion in the pages of the *Elektrotechnische Zeitschrift*. Herr Ziehl* considers that some of Rothert's assumptions apply only to the special case discussed by him and not to Drehstrom machines in general. The assertion that the armature reaction in these machines is due to a constant drehfield equal to $1\frac{1}{2}$ times the magnetising force of one phase is correct for two-pole machines, but not for machines with a greater number of poles. For instance, in a four-pole Drehstrom machine with the usual short winding, the three magnetising components of the phases which form the resultant field, are no longer separated from each other by an angle of 60°, but by

$$\frac{360}{3 \times \text{number of poles}} = \frac{360}{3 \times 4} = 30^\circ$$

The magnitude of the resultant when phase I. has its mamimum value is

$$R' = n\,J + 2\,(0{\cdot}5\,n\,J \cos 30^\circ) \text{ ampere-turns}$$
$$= 1{\cdot}866\,n\,J \text{ ampere-turns}$$

where n is the number of turns, and J the maximum value of the current.

In another position of the drehfield, when the instantaneous value of one of the phases is zero, the magnitude of the resultant is

$$R'' = 2\left(0{\cdot}866\,n\,J \cos \frac{30^\circ}{2}\right) \text{ ampere-turns}$$
$$= 1{\cdot}671\,n\,J \text{ ampere-turns.}$$

These are the two extreme values of the resultant ampere-turns between which all the other values lie. If α is the angle between magnetising components of two adjacent coils of two phases, then the two limiting values of the resultant ampere-turns for any machine are :—

$$R' = n\,J + 2\,(0{\cdot}5\,n\,J \cos \alpha)$$
$$R'' = 2\left(0{\cdot}866\,n\,J \cos \frac{\alpha}{2}\right).$$

The smaller, therefore, the angle α, that is the greater the number of poles a machine has, the nearer the resultants approach to the value $2\,n\,J$. Another point that Herr Ziehl objects to is the assumption that the whole of the ampere-turns contribute to the reaction. Kapp has already shown that this is not the case; as a matter of fact, the demagnetising effect changes according to the sine of the angle of phase displacement between the current and the E.M.F. induced. If, therefore, there is no phase displacement in the external circuit, and if the secondary magnetic leakage produced by the armature ampere-turns is negligible, then in general there is no armature reaction, since $\sin \phi = 0$.

Dr. Haas† points out that Rothert has assumed that the resistance of the magnetic circuit is constant however much the lines of force may be distorted by the armature reaction. This is not the case with dynamo machines where the pole pieces embrace only a part of the armature periphery. It would appear, therefore, to be risky to combine the magnetic forces as equivalent in magnitude and direction; it is necessary also to take into consideration the variations in magnetic resistance. He admits, however, that the errors introduced may not be greater than are permissible in practice.

Rothert, in his reply* to the criticisms of Ziehl and Haas, admits that the factor 1·5 with which the magnetising force is to be multiplied to obtain the resultant ampere turns, varies in different machines, and in any one machine at different phases of its revolution; but what he contends for is, that 1·5 is a good mean value for the factor, when it cannot be more exactly determined by experiment. He entirely dissents from Ziehl's proposition that the nature of the reaction of the armature depends on the number of poles, for a constant primary field (exciting field) must, with a constant magnetic resistance excite a current wave form in the armature of such a form that the combined reaction of the three phases shall be a constant. He considers that Ziehl is entirely mistaken in his application of Kapp's theory to the present theory, since Kapp took self-induction into account; a method which Rothert's theory is intended to get rid of. It is difficult to give experimental proof that the whole of the ampere turns of the armature are to be taken into account, since there are several assumptions in this theory as in the current theory which are necessarily only approximations. But Rothert contends that his theory is simpler and much more easily applied by the dynamo constructor. He admits that Dr. Haas is theoretically right in his objection as to the change of the resistance of the magnetic circuit with different armature reactions, but he considers that the errors due to this cause are negligible in practice.

Herr Max Vogelsang† thinks that the ordinary theory of magnetic leakage adopted by Rothert may be incorrect. Vogelsang considers that magnetic leakage is due to the collision of lines of force in the magnetic circuit, and not to difference of magnetic potential. His theory leads to different results from the usually accepted theory, and would require experimental verification before it could be adopted in practice. He also objects to the combination of magnetising forces by the parallelogram of forces as proposed in Rothert's theory.

Herr Rudolf Braun‡ considers that Rothert's treatment of armature reaction in Drehstrom generators is too special. He shows, also, that Ziehl's generalised formula for the resultant ampere turns is incorrect. He considers that each component must be treated separately. When this is done through one period, the resultant ampere turns used as a radius vector describes an ellipse; in practice the ellipse is of a jagged and irregular shape. After the resultant has been determined in magnitude and direction for each phase of the period, it may be combined geometrically with the ampere turns of the exciter; the angle between the direction of these two components is influenced by the displacement of phase between the current and the tension.

Herr Behrend§ points out that a similar theory to Rothert's, was published by Dr. Behn-Eschenburg in the *Elektrotechnische Zeitschrift* in 1892. He considers also that in dealing with alternators the maximum value of the ampere turns should be used, not the mean value as stated by Rothert. This follows when we consider that the number of lines of force produced by the armature is proportional to the maximum ampere turns of the armature; since experiment shows that effective ampere turns depends on the arrangement of the bobbins, &c.

Herr Heyland‖ continues the discussion by demolishing the views of Vogelsang, Ziehl, and Braun.

Rothert¶ again replies to his critics. He asserts that his theory is different from that of Behn-Eschenburg; that, in fact, it was after he tried this latter theory and found it wanting, that he evolved his own. Several other writers have taken part in the discussion, but Rothert on the whole appears to have decidedly the best of it. His theory, on account of its simplicity and its close agreement with the results obtained in practice is well worth the attention of the builders of polyphase generators and motors. Rothert intends to bring out, at an early date, a treatise dealing fully with the whole subject.

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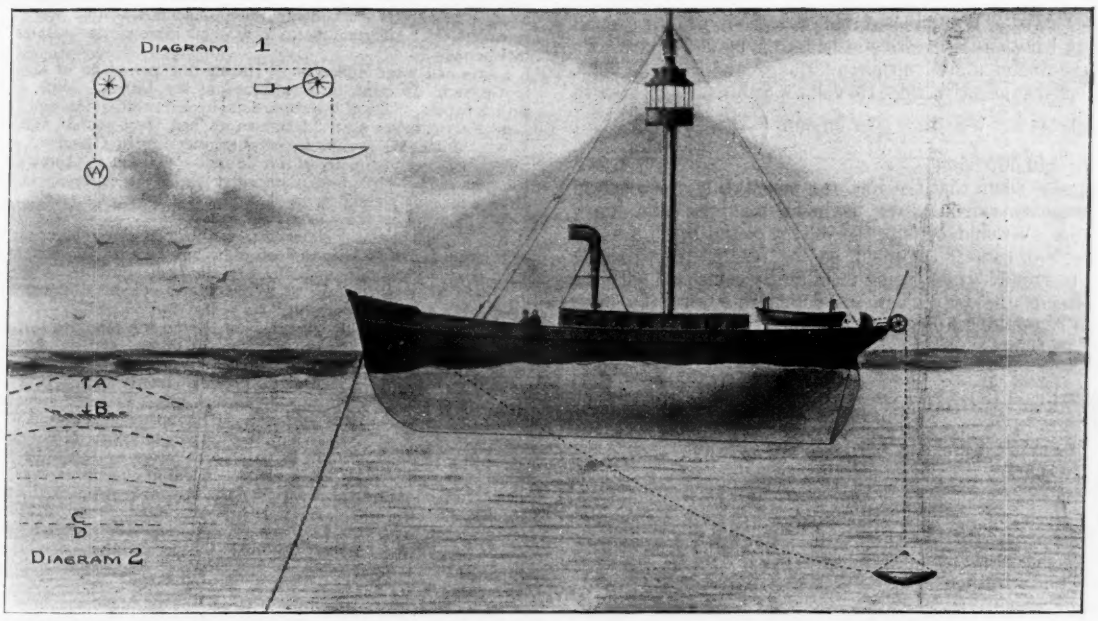
* *Elek. Zeit.* Vol. xvii., p. 642.
† *Loc. cit.*

* *Elec. Zeit.*, p. 683.
† *Elek. Zeit.*, p. 700; ‡ *loc cit.*
§ *Elektrotech. Zeitsch.*, p. 715; ‖ *loc cit*, p. 728; ¶ *loc cit*, p. 740.

LIGHT-SHIPS AND THE UTILISATION OF SEA POWER.

We illustrate a simple accessory to light-ships and the like, the design of Mr. Scott Snell, by which he claims power may be obtained, say, in the form of compressed air, to operate the fog horn, or to assist in getting in the slack cable paid out during heavy weather. Essentially, it consists of a disc of any desirable dimensions, preferably of cupped form, and fitted if necessary with upward opening flaps or valves, so that it may readily sink, but powerfully resists an upward pull. Sunk at a depth below the influence of wave movements, it is virtually in still water, and the rise and fall of the stern of the light-ship produces an intermittent pull upon the chain connected to the disc below. When the stern descends it is plain that if the slack chain be gathered in, such as by a counterweight in the hold of the vessel (see diagram 1), it will be drawn out again as the stern rises, by reason of the resistance of the disc. Assuming, now, that the pulley at the stern or elsewhere is a chain wheel, and to its axle is connected a set of air or water pumps, we then get continuous operation, at least, until a state of absolute calm supervenes.



By a pawl and ratchet action, the pumps may be worked only on the lifting of the vessel, or if the weight be considerable, both rise and fall may be used.

Diagram 2 shows the varying range of vertical oscillation at different depths, the vessel being subject to the movement at A, B; but the disc only by that at C, D, which is practically nothing. Many of our readers will recollect that we gave in an issue in December, 1882, an elaboration of this diagram, with more exact details of such movements, also calculations of energy in sea waves, the whole being part of a paper on "The Sea, a Source of Power" before the Engineering Association of New South Wales, which Mr. Scott Snell read in 1881, and which he brought to our notice upon his return to England in 1882. This paper was published by the Association, and dealt more fully with the use of such discs than we can spare space for. We merely illustrate a single application; but it is easy to imagine it might be applied to utilise the rolling, as apart from the pitching, of a vessel; it might, indeed, render useful service in operating the pumps of a sailing ship in certain latitudes where excessive rolling takes place, in spite, or indeed on account of the absence of wind, which would steady the vessel. Many other applications of this principle will suggest themselves.

USE OF VOLTMETERS FOR INSULATION RESISTANCE MEASUREMENT.*

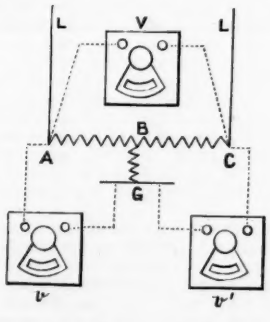
By Wm. R. C. Corson.

It is frequently desirable to determine the resistance of the insulation between the ground and a system of wiring, a dynamo, or other translating device, while the system is in operation, and for this purpose the method described below will be found convenient. The formula is by no means new, but as the writer can find no article in which its derivation is published, and as he has met so many electrical workers who were not familar with it, to whom the method would be of advantage, it has appeared probable that its publication would be of some interest.

In the diagram, L, L, represent the mains of the constant potential circuit, A, B, C, is the system or translating device grounded at some point or points, B. It is desired to find the resistance of the insulation, B, G.

One voltmeter is used, the resistance of which is known, and readings are taken across the mains, denoted by V, between ground and positive main, denoted by v, and between ground and negative main, denoted by v'.

V′ is the sum of readings v and v', R is the resistance of the voltmeter, and s is the resistance of the ground insulation,



which it is desired to determine. Now, drop of potential in A B + drop in s + v' = V; or drop in

$$\text{A B} + \frac{v'}{\text{R}}\, s + v' = \text{V}. \qquad (1)$$

* *American Electrician.*

and drop in

$$\text{B C} + \frac{v}{\text{R}}\, s + v = \text{V} \qquad (2)$$

adding (1) and (2), drop in A B + drop in B C + $v + v' +$

$$s\,\frac{(v + v')}{\text{R}} = 2\ \text{V}. \qquad (3)$$

But drop in A B + drop in B C = V, (4)

and $v + v' = \text{V}'$. (5)

Substituting these values in (3),

$$\text{V}' + \frac{s\,\text{V}'}{\text{R}} = \text{V}; \qquad (6)$$

$$s = \text{R}\,\frac{\text{V} - \text{V}'}{\text{V}'}. \qquad (7)$$

It will be noted that there is a slight error in these equations, and that they will only be correct on the assumption that the combined resistance of voltmeter and ground is so great that the current flowing through the path will not affect the drop in potential through such conductors as A B and B C. This assumption is always necessary in measuring drop of potential with a voltmeter.

Let us take an example or two.

We have a Weston portable voltmeter whose ground reading between the positive resistance is 60,000 ohms. We find the line of a 500 volt circuit and ground to be 35 volts, and on the negative side 15 volts. Substituting these in formula (7). We have $s = 60{,}000\left(\frac{500 - (35 + 15)}{50}\right)$ or $s = 540{,}000$ ohms.

Suppose again that the line was metallically grounded on the negative side, and let us make readings, and apply formula. V would be 500, the voltage of the line; v would also be 500, because it would be the reading from positive main to ground which, being metallically connected with the negative main, has taken its potential. For the same reason v' would be 0. Formula would become $s = 60{,}000\left(\frac{500 - (500 + 0)}{500}\right)$ or $s = 0$, which, of course, was to be expected.

WATT AND THE MEASUREMENT OF POWER.*

By WILLIAM HENRY PREECE, C.B., F.R.S., Engineer-in-Chief and Electrician, General Post Office, London; Vice-President of the Institution of Civil Engineers, &c.

JAMES WATT, who died 77 years ago, was a great inventor. He was "one of the most illustrious followers of science, and one of the greatest benefactors of the world." If he had never improved the "fire engine" of his, the "steam engine" of our day, the copying press alone would have maintained his name on the scroll of inventive fame. His greatest invention—that which has been most prolific in exciting further improvements in the steam engine, and which has supplied the engineer with a new sense—is perhaps the "indicator."

The indicator enables an engine itself to record automatically on paper a diagram which, properly interpreted at leisure, conveys a clear history of the performance of the steam in the cylinder. It enables the engineer to measure the actual work that is being done by it, and it gives a report of the action of the valves and parts which control the ingress and egress of that steam, and which regulate the performance of the machine. It gives an insight into the internal actions of the machine, which, being out of the range of direct observation, are so liable to be misinterpreted. It is to the engineer what the stethoscope and the thermometer are to the physician.

Accuracy in measurement is the foundation of engineering, and the secret of practical success. It leads to the detection of error, and to perfection in working. No instrument has been more productive of improvement in this respect than Watt's indicator, and few instruments have been found to require less modification.

The conception and development of this apparatus showed that Watt was a long way before his time in grasping the doctrine of energy, and applying the practice of graphics.

With such an extensive literature on the subject, and with its universal employment by engineers, it is unnecessary to describe the instrument. I content myself by showing you side by side Watt's original instrument,* 112 years old, and the most recent form, designed to meet the requirements of modern machinery.

In his patent of 1782, describing his application of the principle of expansion to the economical working of the steam-engine, Watt drew a diagram, which I reproduce, showing how much he was before his time in the use of graphics, and in the conception of the principle of energy. It is quite clear that this mode of looking at the work done in the cylinder led him to consider its automatic record. It was only necessary to know the length of stroke, and to indicate the pressure of the steam upon the piston exerted during each instant of its movement to obtain the factors of the work done during each stroke. A curve is thus formed by a pencil on a sheet of paper which by its shape gives the whole history of the performance of the engine. The area of the curve, although it contains nearly all we want, is not that which we require to know so much as its mean height. The horizontal length gives the time of one stroke. The mean height gives the average pressure exerted during the stroke. We thus learn the work done per stroke, and by multiplying this amount by the number of strokes per minute, and knowing the dimensions of the machine, we obtain the total work done per minute.

The principle of work lies at the very root of the profession of the engineer; Watt gave us not only the means to measure it, but a system to indicate it. Work done means resistance overcome. It means the application of force through distance against this resistance. In Great Britain we employ as our practical unit the force or weight of one pound. Our lengths are measured in feet. Thus if we raise 1 lb. 1 foot high against the resistance of gravity, we do an amount of work which we moderns call a "foot-pound," though Watt did not. The "foot-pound" conveys to them who habitually use it the conception of a reality as distinct as 1 lb. of butter. The engineer, like Shakespeare's poet, gives to airy nothing, not only a local habitation and a name, but a concrete existence. The French unit of work is larger. It is a kilogram raised one metre against gravity, and is called the "kilogram-metre." The kilogram-metre contains 7·23 foot-pounds.

I have had some difficulty in tracing the parentage of the term foot-pound. It came into existence in the forties. Joule, in his earlier papers, spoke of the work done by 1 lb. acting through 1 foot. Lord Kelvin writes me: "I believe we had 'foot-pound' first from Lewis Gordon, the first professor of engineering in Glasgow University (1844), the first really of the United. We used it thoroughly in Glasgow when I came from Cambridge to be his colleague in 1846. Joule was much pleased to use it, I believe—in fact, almost remember—that he got it from me."

The English engineer is forced to use the pound weight as his unit of force, not because he is wedded to it, but because the pound and yard are the legal units prescribed by the Legislature.

When Parliament thinks fit to introduce a decimal and metrical system the change of units will be easily effected, and we shall experience the inestimable advantage of having one absolute system of measurement employed alike, not only by science and by practice at home, but universally by all European nations.

It is not generally known that James Watt proposed, in 1783, a new and decimal system of weights and measures. His unit length was based on the seconds pendulum. His unit weight was to be the unit cube filled with water, and he proposed to weigh all liquids and gases in terms of this unit in order to express by the same figure specific and absolute weights. There is reason to believe that these ideas were instrumental in framing the splendid system finally made legal in France, in 1801, for Watt himself visited Paris in 1786, and was in intercourse with La Place, Monge, and other members of the Committee of the Academy dealing with the question. Nothing can prevent this system, probably the child of Watt, from ultimately becoming universal all over the civilised globe.

Now Watt, in introducing the steam engine, found the chief competitor he had to meet was the horse. It worked the pumps in mines and "brewhouses." It drew the ores to the surface. It was employed for grinding and for milling. It was clear that his customers would compare the performance of his engine with that of their horses. He determined by experiment that a good horse working continuously, could raise 22,000 lbs. 1 foot high in one minute. He thought he would go "one better;" so he said, "I will call 33,000 lbs. raised 1 foot high in one minute a horse's power." Thus he gave his customers the advantage of 50 per cent. more work; but he did more, instead of compelling them to keep relays of horses, each of which could not work continuously more than six or eight hours, he gave them a machine which worked continuously throughout the 24 hours. He showed, moreover, that in Whitbread's brewhouse his engine "does the work for which 30 strong horses were kept, and consumed $\frac{4}{10}$th bushel of coals per hour."

The above definition of a horse's power was singularly unfortunate. It means 15 tons moved at a snail's pace. Few people can grasp the conception. We know what a man can do, especially when rowing a race or when raising bricks. Going up a mountain at the rate of 1,000 feet per hour—a fair performance—he does about $\frac{1}{2}$th of a horse's power (H.P.) if he weighs 12 stone. Working a treadmill absorbs $\frac{1}{4}$th H.P., which is distinctly hard labour. If he runs upstairs at the rate of $3\frac{1}{2}$ feet per second he does 1 H.P., and this is not good for his heart. We also know what a horse can do in drawing a cart or moving a canal barge. "550 lbs. moved 1 foot per second"—the leisurely pace of a child walking—is more comprehensible than, and the same thing as, 33,000 foot-pounds per minute, and is now more frequently used, especially abroad.

But Watt was not the first to use the term "horse's power." Savery did this in 1702. "An engine," said Savery, "which will raise as much water as two horses, working together at one time in

* Delivered at Greenock, February 5th, 1897, being the "Watt Anniversary Lecture."

* Kindly lent by Mr. George Tangye, of Birmingham.

such a work, can do, and for which there must be constantly kept 10 or 12 horses for doing the same, then I say such an engine will do the work or labour of 10 or 12 horses." Watt, however, gave the unit a scientific character and was virtually its founder.

He thus introduced the conception of power as the rate of doing work. His unit of work was 1 lb. raised 1 foot high, irrespective of the time in which it was done; but by conceiving this being done in a unit of time he conveyed the idea of power, a scientific definition of a much-abused term. Boulton said at Court to George III.: "I am engaged, your majesty, in the production of a commodity which is the desire of kings." "And what is that—what is that?" asked the King. "Power, your majesty."

Again he was anticipated, for Smeaton, in the *Philosophical Transactions* for 1759, in describing his experimental inquiry concerning the natural powers of water and wind, said, "The raising of a weight relative to the height to which it can be raised in a given time, is the most proper measure of power." Watt did, however, introduce the term "duty" to determine the comparative merits of steam engines. It was introduced by him in Cornwall, and is often known as the "Cornish million," for he determined how many pounds could be raised one foot high by burning a bushel of coal in his boiler, and found that this could be expressed only in millions.

Watt's bushel was subsequently changed in this country to 1 cwt. (112 lbs.), and in the United States to 100 lbs. It has now become practically obsolete, for more effective and more uniform means are adopted to express the relative efficiency of engines.

The term "horse-power" has probably seen its best days. It is gradually being displaced, and with the advent of the metrical system it will disappear. As a scientific term it has been much abused, and as a commercial term it conveys no meaning. Sir Frederick Bramwell wrote, in 1883:—

"A barrister lately said to the same writer of this report, 'You surely do not mean to tell me that you do not know what a horse-power is—you that have been a mechanical engineer all your life?' The answer given was, 'Indeed, I do not, there is a difficulty in the outset; what sort of horse-power do you mean?' 'Why, I mean a horse-power.' 'I know you do; but there are five kinds of horse-power.' 'Five kinds! impossible, it can't be?' 'But there are. I will give you the names and the nature of them: (1) The real horse-power, the power of a horse estimated to lift 22,000 lbs. one foot high per minute. (2) That which in James Watt's time was called the nominal horse-power, a horse-power of 33,000 lbs., raised 1 foot high per minute, which power he gave all his early engines, so that the purchaser, having one and a half times the power of a good horse, should not be in a position to complain of the engine as inadequate. This term nominal is now commonly confounded with the commercial horse-power, and the name, theoretical horse-power, is substituted to represent that which was received as the scientific horse-power of 33,000 foot-pounds. (3) The gross indicated horse-power. This is the whole power developed on the piston of the engine without any deduction for friction, which power, divided by 33,000, gives the gross indicated horse-power. (4) The net indicated horse-power. This is the same as the foregoing, minus a certain allowance for friction. (5) The commercial, or, as it is now frequently called, the nominal horse-power. This is a horse-power about which no two persons can agree.'" Sir Frederick Bramwell might have added a *sixth*, viz.: Electrical horse-power, that which appears in the circuit, or electrical energy.

Is a horse-power really a horse's power? Tredgold made it 27,000 foot-pounds per minute for eight hours. Rennie assumed 22,000 as correct. Beardmore had a horse weighing a little over half a ton, which did 39,000 foot-pounds per minute for eight hours a day. Morin made it 26,150 foot-pounds. Two horses will tow a canal boat at 2½ miles an hour, while a steam engine of 10 H.P. is needed to do the same work by means of a screw. Tramcars are drawn by two horses at a speed which the so-called 25 H.P. motor can scarcely do. The horse is really a more efficient machine for a time than the engine, and its "pull" can be directly applied, but he tires, and sickens, and dies. He is better adapted to certain kinds of work. He can at times expend much more energy than the so-called horse-power. At other times he is helpless and hopeless. Thus it appears clear that a horse-power is not a horse's power.

The horse-power is based, as I have pointed out, on the British units—pounds, feet, and minutes.

Scientific men are now universally using a system of units based on the "centimetre," "gramme," and "second"—hence called the "C.G.S." system, to distinguish it from the "F.P.S.," or British engineers' system. In this system, the unit of work, viz., 1 gramme moved through 1 centimetre against unit force is very small, but 10,000,000 of these small units are taken and are called, in honour of our great British experimenter, the "joule," and become a practical unit of work. Thus Joule's own mechanical equivalent, the work absorbed in raising the temperature of 1 lb. of water 1° F., at or about its maximum density, indicated in the "F.P.S." system at 778 foot pounds, is in the "C.G.S." system the work absorbed in raising the temperature of 1 gramme of water 1° C., at or about the same maximum density, as 4·2 joules. Thus the joule is to the foot-pound as 1 to 1·356, and the horse-power, instead of being 550 foot-pounds per second, becomes 746 joules per second. The joule per second, or the unit of power, has now been universally called a "watt"; and thus in the new system the rate of doing work, that is, the power developed by the steam engine, or any other machine, or by any other process, mechanical or physical, is most appropriately indicated in units bearing the name of our great Greenock inventor. The term watt was applied in 1883 by the late Sir William Siemens to the joule per second, but I had previously, in 1881, at the Paris Congress, proposed to apply it to 1,000 joules per second. Siemens's proposal has been preferred, and in consequence the practical unit of power comparable with the horse-power becomes the *kilowatt*. Had my proposal found favour, the practical unit of power would have been the watt, and Siemens's unit would have been a milliwatt. I venture to think the acceptance of my unit would have hastened the departure of the term horse-power.

I was surprised and pleased the other day to find in Marseilles that the man directing the electric tramcars in that city corresponding to the driver of the old horse car, sometimes called in America the motorneer, is called the *wattman*, and I have since learnt that this term is very general in France. I hope our friends in Glasgow who are about to introduce electric traction in their city will follow France's good example, and honour one of their greatest mechanical heroes by inaugurating the same name in Great Britain.

Energy, though so protean in its character, retains its joule throughout all its changes. Every joule impressed on the surface of the ocean by the rays of the sun adds to the moisture of some cloud which, condensed into rain by contact with our cool highlands, feeds a river like that which forms the Falls of Foyers. The engineer directs this falling water through the blades of a turbine, and each joule that passes assists in rotating dynamos to excite strong electro-magnetic fields and powerful currents of electricity, which in their turn produce light, the intensest heat known and chemical decomposition. This lump of aluminium, the first produced at Foyers, has been extracted from crude bauxite by the expenditure of about 60 million joules.

Thus in every stage of its transformations the joule remains the same mechanical unit, whilst the energy that it measures outproteuses Proteus.

The grand principle of the conservation of energy teaches us that no energy is ever lost. The total energy present assumes a form either useful or useless to man. The skill of the engineer is devoted to render that which is useless useful, and no one has helped him to do this more thoroughly than James Watt.

The rapid introduction of electrical energy for electric light, for traction and for the transmission of the waste powers of nature to distant places is revolutionising our systems of units. The British Association in 1861 formed a committee to consider the question of general electrical measurement, and aided by Wheatstone, Varley, Balfour-Stuart, Siemens, Matthiessen, Clerk-Maxwell, Joule, Fleeming Jenkin, who have departed, and Lord Kelvin, who remains as active as ever, they have so impressed the world by their work that, aided by the Congresses in Paris in 1881 and 1883, in Chicago in 1893, and by the action of the Board of Trade in London in 1894, the system proposed has been universally adopted, so that electricians in all parts of the world, whatever their nationality or their language, use the same terms, the same measures, and the same units. The ohm is the unit of the resistance, which has to be overcome in any case of the flow of electrical energy; the volt is the unit of pressure which maintains this energy through this resistance; the ampere, the result of one volt acting through one ohm, is the unit of current, and the coulomb is the unit of that electrical quantity which is being driven. These are electrical units pure and simple; but leading from, and associated with them are the mechanical units—the joule and the watt.

The watt is universal and exact; the horse-power is not. The latter equals in—

England	...	...	550·00 foot-lbs. per second
France ...	...	...	542·47 " "
Germany	...	...	582·25 " "

How can one reconcile such discrepancies? Yet the horse-power is maintained in high places with all the fervour and enthusiasm of an old Scotch covenanter, or the *non-possumus* of a good old English Tory.

The foot-pound per second equals 1·356 watt. The horse-power therefore equals 746 watts. The watt equals 0·7373 foot-pound per second. The kilowatt, 1,000 watts, equals 1·34 H.P.

If, in order to obtain the value of the power, we divide by 33,000 the ordinary formula, $A P S n$ where A is the effective area of the piston in square inches, P the mean pressure of the steam in pounds per square inch during one stroke, S the length of this stroke in feet, and n the number of strokes per minute, we get it in horse-power. If we divide it by 44,238, we get it in kilowatts.

Horse-powers multiplied by 0·746 are expressed in kilowatts, and kilowatts multiplied by 1·34 are expressed in horse-power. The new system is universally used by electrical engineers.

Names, when well selected, secure precision of language; a watt is a watt, and nothing else. A pound, on the other hand, may be either a force or a mass or inertia. Names fix ideas. Every electrical workman has a definite and clear conception of an ohm or an ampere. He requires no definition to impress them on his mind. The name alone conveys to him all he wants to know. They become fundamental ideas. There is no ambiguity, hence there is no difficulty either in teaching or in practice. The same benefits would certainly arise if we applied the term kilowatt to the unit of power. No one would have to ask, "What sort of kilowatt do you mean?"

The same principle which enabled Watt to examine the interior of his cylinder, enables the electrician to examine and record the behaviour of his plant and his circuits.

Power houses which generate electric currents for supplying electric light or for working trams, are generally supplied with recording instruments that tell of the energy expended at each instant of the 24 hours. The engineer has thus before him every moment the history of the whole previous day's work. Here, for instance, is a record of a whole day's work in Rome, and here a record of another day at the General Post Office in London.

We are able by means of meters to measure water consumed or gas burnt in our premises. The former is sold by the 1,000 gallons, and the latter by the 1,000 cubic feet. Similarly we measure in 1,000 watts the electrical energy that is utilised per hour in our houses and factories by the "kilowatt-hour"—that is, we pay 6d. for every 3,600,000 joules we direct to meet our wants.

The custom of paying for power applied is by no means a modern

innovation, but it has recently been made legal by the Electric Light Act of 1882. That Act makes legal as a Board of Trade standard or unit a "kilowatt-hour." It is there defined as a 1,000 volt-amperes per hour, the watt had not then been adopted. Thus the Board of Trade unit becomes a unit of work done, and we are able to sell as a commercial commodity "the work done" by a kilowatt, or, in Watt's langauge, the work done by 1⅓ H.P. in one hour.

Through the kindness of Lord Kelvin I am able to show you many forms of meter, the offshoot of his own genius and his industry. There is no one who has done so much to secure accurate, sensitive, and reliable instruments of precision and of measurement.

Electrical energy is supplied in Glasgow for 6d. per unit, for the kilowatt-hour has not yet received a name. It was proposed to call it the "Kelvin," and a more appropriate name could scarcely be found, for who is more entitled to share the glory of Watt's name than he who has again made the Glasgow University so famous?

Lord Kelvin himself objected to its introduction, but in a case of this kind personal wishes scarcely can control the public will, and the necessity for a name is becoming so strong, that I shall not be surprised to find electrical energy sold at so much per kelvin, even though it is measured by a Kelvin meter.

I should have liked very much to have diagnosed the causes which have led Scotch Universities to dominate so strongly the advances of practical science. The pages of the history of the branch of engineering I have so lightly touched upon teem with the names of Watt, Rankin, Clerk-Maxwell, Fleeming Jenkin, and Lord Kelvin—great towers of light that have brightened up and hastened our rapid progress. Why is it thus? Is it that it needs the strong common-sense influence of practice and the wholesome conception of utility, so characteristic of the North, to be impressed on the abstract views of pure science to secure concrete advances in its practical applications? Our English universities are, in this direction, out of the running. They adhere to abstract science. But in Glasgow the doctrine of energy has been crystallised and applied; it is from Glasgow that so much of our engineering knowledge has emanated, it is to Glasgow that we shall continue to look for more light, and it is therefore to Scotland that we must accord all honour.

GASEOUS FUEL AS A MEANS OF CHEAPENING ELECTRICITY.*

By NELSON W. PERRY, E.M.

In these days of extending areas to be reached by electric light and power companies, the management is constantly being put into a quandary as to how they are to be reached. In electric lighting enterprises employing the direct current, the areas that can economically be reached are already pretty well covered, and these are the best paying areas. Just beyond there is new business to be had if it could only be supplied, but to supply it would involve additional outlays far out of proportion to the reasonable expectation of immediate returns. The management, therefore, feel that they must for the present, at least, forego the immediate increase from these outlying districts, and must depend for new business upon the natural or stimulated growth of custom within the districts already partly supplied.

Where the alternating current is employed very largely increased areas are so easily made tributary to the central station that the temptation to supply scattered customers has been, in most cases, too strong to be resisted, and I believe if reliable statistics could be compiled, they would show that alternating current lighting stations have proved far less profitable as a class than have those using the direct current. The very limitations which have prevented the direct current entering the field to which the alternating current is best adapted, having proved its greatest safeguard.

A comparative study of a very large number of load lines of direct and alternating current lighting stations discloses a peculiar state of affairs, viz., that as a rule the alternating current load lines have almost uniformly a squarer and broader topped peak than have the direct current stations. This is largely due in some cases to the fact that in the scattered service of the alternating current a very much larger proportion of the total output is employed for street lighting, but it is also partly due to the undoubted fact of the larger proportionate losses at light loads due to transformer and other losses peculiar to the alternating current, which makes the mean load higher than it should be. This feature is particularly observable in the curves of an alternating current station, of which I have diagrams for nearly every day in the year, which supplies such a small proportion of its total output to street lights as to render the effect of these practically negligible.

With the direct current system, the introduction of high voltage lamps, which have already demonstrated their feasibility abroad and to a less extent in this country, will be a partial solution of the question of supplying greater areas if it does not lead to the same temptation which has beguiled the alternating current manufacturers, for of this there is constant danger.

In electric railways, in which distances rather than areas are involved, the question is far more serious, for in this latter case the cost of distribution increases almost strictly as the square of the distance, whereas in electric lighting the cost approaches more closely to a direct proportion to the distance.

This comparison becomes more strictly true when we consider the suburban extensions of our electric roads, which, in fact, now are becoming about the only extensions open to our street railway managements, and the unfavourable character of the comparison puts the street railway problem in a still more unfavourable light when we consider that in the outlying districts the immediate traffic to be gained by the largely increased outlay is disproportionately small to that outlay, and of a far more irregular character.

In order to make such new lines profitable at all it has become quite popular to stimulate traffic by inaugurating pleasure resorts and providing amusements at the further end of the line. The wisdom of this is questionable, for to provide for this increased traffic, provision must be made both in the way of increased plant and in additional copper largely in excess of the natural demand. This increased provision is at best utilised but a small portion of the time, and the earning capacity of the investment as a whole is greatly decreased.

Returning to the electric lighting industry, it is at best on an unsatisfactory basis, and something must be done to better it. In the most desirable locations, which are in our largest trade centres, such as Chicago, New York, and Boston, where probably of all places in the world the electric lights are most dense, and, therefore, where they can be supplied at least cost for distribution, what do we find? We find those companies whose stocks are selling above par, and which are paying dividends regularly, making new issues of stocks and bonds or applying for permission to do so, in order "to raise funds for extensions."

Take the New York Edison Illuminating Company as an example, whose stations are perhaps as favourably located as any to be found, and whose stock is selling above par. It has capital stock of $10,000,000, of which $7,938,000 have been issued, and of bonds $7,118,000, of which $6,430,000 have been issued, making a total authorised capital liability of $17,118,000, of which $14,368,000 has been issued.

According to its report for 1895 its total maximum capacity was 75,000 amperes, or the equivalent of 150,000 16-C.P. lamps. According to Mr. John W. Lieb (*Transactions* American Institute Electrical Engineers, 1895, p. 56), the load factor of the combined Edison stations on the day of the greatest output in 1894 (December 10th), was 34½ per cent.

To compare the capital outlay for electrical service with that required for equivalent gas service is exceedingly difficult; first, on account of the paucity and unreliability of gas statistics; and, second, because of the well-known enormous over-capitalisation of gas enterprises in New York, partly due to the watering of stocks and partly to the duplication of plants that would have been totally unnecessary had the gas industry grown legitimately under a single head instead of being the outgrowth of repeated consolidations of competitors in the same territory. But taking these statistics as we find them, the total authorised capital of the various gas companies, including stock and bonds, is given as $58,109,000 and their united annual output, as near as I can get it (average of two estimates by different gas authorities), 14 billion cubic feet. This gives a mean output per hour of 1,600,000 cubic feet. Counting 5 cubic feet per hour as the equivalent of a 16 C.P. incandescent lamp, this means an average supply of 320,000 lamps, and if the load factor be assumed the same as given for the Edison stations, it means a maximum supply for something more than 927,000 burners. This is in round numbers 6·2 times as many lights as the Edison Company on a total authorised capitalisation of $171,118,000 is able to supply. On this basis the capitalisation necessary to supply the same number of lights as the gas companies can now furnish, would be $106,000,000 as against $58,000,000 for the gas companies. For many reasons, some of which have been specified, the comparison is manifestly unfair to gas, and it seems not at all improbable that gas service can be supplied on a capitalisation of not to exceed one-fourth (instead of one-half as shown above) that required for equivalent electric service.

There is certainly something wrong in this state of affairs, which the electrical engineer must correct. The most significant feature of the situation is that notwithstanding the fact that gas is distributed over very much greater distances than low tension currents are, the consumer can buy it so cheaply that he can produce electric light more cheaply by burning it in a gas engine even after incurring the losses in conversion in the engine and dynamo, than he can buy it from the electric company. If this be true in large cities like Chicago, New York, Philadelphia, Brooklyn and Boston, and it cannot be gainsaid, what must be the condition of light and power plants in smaller and less favourably situated cities?

Some, by rigid economy and the best of management, are making a little money; some are running on a very close margin, and still more are undoubtedly eking out a precarious existence while their machinery is wearing out and making no provision for its replacement when it requires renewal; and all are charging more for their light than gas can be and is furnished for, where gas is furnished at all. It is very clear if the electric light could be furnished at a small profit at the same price as gas, it would furnish an enormous increment to the electric light manufacturer's income. The advantages of electricity as a useful agent in the household over gas are so apparent that there could no longer be any competition between the two. It would result in larger profits for those companies now making money and place most of those now operating at a loss upon dividend paying basis.

Our electric railways, except in exceptionally favoured situations, as in our larger cities, are in no better condition than the lighting companies, if, in fact, they are in as good condition.

Our electrical engineers have bent every effort to ameliorate matters, and the best of our electrical stations are now models of mechanical and electrical engineering skill. Boilers of the highest efficiency, engines of the greatest economy, and all the accessories have been brought to a state of perfection which leaves little expectation for improvement in those directions. Greater distances have been

* Read before the North Western Electrical Association at Milwaukee, January 21st, 1897, and courteously sent to us as an advance proof by Mr. Perry.

brought under the service of existing stations by means of the booster and of subsidiary outlying storage battery centres of supply and the load line has been levelled off by the storage battery plants at the station itself, and yet the most optimistic will not maintain that finality has been reached or that the desired end has as yet been accomplished. Electricity can be produced at the station by large compound condensing engines more cheaply than gas light at the gasworks.

If we assume that illuminating gas costs but 20 cents per 1,000 cubic feet to manufacture, and that 5 cubic feet per hour are consumed to produce 16 C.P., the cost per light per hour at the gas works would be one-tenth of a cent. If, on the other hand, we assume that an electrical H.P. hour can be produced at the central station for one cent, and that 13 55-watt lamps can be supplied thereby, they would cost one-thirteenth of a cent per hour.

When we still further consider that recent tests in England have shown that a brake horse-power can be produced under test conditions in a gas engine on 14 cubic feet of ordinary town gas (16 C.P.) and that such gas costs, delivered in our large cities, only about $1.50 per 1,000 cubic feet, it becomes evident that we can pay the gas company its profit on manufacture, distribution, and collecting and still produce electric lights in our central station at a less cost than gas light; and yet when we have distributed our energy to our customers we must charge them more than the gas company does, light for light, and then be satisfied with far less profit on an increased investment than the gas company gets on its lesser investment. It seems to me that this indicates something radically wrong and in a direction to which our engineers have given little attention, viz., in our methods of distribution.

We have constantly striven to increase our radii of distribution and have done this until we could go no further and give satisfactory service. We have then built additional stations, and many managers now find themselves again confronted with the same question—is it possible for me to increase my radius, or must I decide between foregoing the increased business just beyond my reach, or taking the bull by the horns, build another station?

(To be continued.)

REVIEW.

The Engineer's Year Book. By H. R. Kempe. London: Crosby Lockwood & Son. 1897.

This year book now appears for the fourth year of its life, and has grown in spite of the elimination of much of the original matter which it did not appear to be desirable to maintain. It now numbers 656 pages. The section on locomotives has this year been re-written by Mr. Geo. Hughes, of the L. & Y. Railway, and we note that a section has been added which deals in as simple a manner as possible with the transformation of linear arches in a manner suitable for tunnels. But the principal additional matter is that on electric tramways, which has been entirely re-written by Mr. Scholey.

Other minor information has also been added, and generally everything done to render the book in every sense what it professes to be. Every year adds to its usefulness and reliableness, and we note even a page given to motor cars and the rules which at present are intended to regulate their construction, so that it is evident that care has been taken to bring the book up to date in every sense. The printing and general get-up, as before, is very good, and the book forms, in fact, quite an encyclopædia of engineering knowledge.

CORRESPONDENCE.

The Pioneer Lamp.

As your description of the "Pioneer" lamp is likely to convey an erroneous impression as to the position of the "Jandus" arc lamp, we trust you will kindly allow us space to give our version of the story.

Enclosed arc lamps—with single globes—are "as old as the hills," as probably Mr. Marks himself will admit.

Mr. Marks's claim was for a particular form of gas check on the already well-known single globe; his lamps, like those of his predecessors who employed single globes, were a practical failure, and it was at this time that Mr. Jandus introduced the double globe, together with the use of the long arc, which at once opened up a new era.

The "Jandus" lamp having proved a gigantic success wherever submitted to fair criticism and test, innumerable arc lamps have been produced on very similar lines—amongst others the "Pioneer."

The "Jandus" patents describe in detail what is undoubtedly the best solution of the problem, and we have every hope that the claim relating to the surrounding of the inner globe with inert gas will enable the company to prevent the pirating of a successful invention.

The opinion of other experts agrees with our own on this subject, and, although the company have no wish to stop the legitimate progress of trade by establishing a vexatious monopoly, there is little doubt that they will spare no expense or trouble in regard to those who are unwilling to recognise the Jandus invention and take a license, as has already been done in the case of the "Stewart" lamp—against which company proceedings were commenced.

We notice that you again revert to the question of light for energy consumed, qualifying it in this instance as the opinion of rival makers.

Do please, Mr. Editor, step down to Messrs. Johnson and Phillips's works at Charlton, where you can see half the yard lit with "Jandus," and half with the best of the old-fashioned lamps—each taking a similar number of watts; there can be no two opinions as to which part of the yard is better illuminated.

There are now well over 20,000 Jandus lamps in daily use, so that you must see for yourself that there is no longer any question as to the merits of the invention.

Although, therefore, those who have tried the lamp are not likely to be misled by the statements in your last issue, we are bound to refer to the matter again for the benefit of the cautious, who are still hesitating to adopt the "Jandus" lamp.

Drake & Gorham.

February 9th, 1897.

[Our correspondents have failed to perceive that we do not revert to anything. The article in question is a translation, as was very clearly pointed out at the beginning. We have nothing to say against the Jandus, but hope shortly to say something in its favour. In the meantime, we congratulate Messrs. Drake & Gorham on the success which has attented the introduction of the lamp into this country.—Eds. Elec. Rev.]

Commutatorless Continuous Current Dynamo.

We think it will be of some interest to your readers to learn that we have imagined and constructed a continuous current dynamo without commutator.

We know that several dynamos of that description have been made and tested, but they were all experimental machinery, without practical utility.

As far as we know, the principal cause of these failures has been mechanical difficulties of construction in dynamos of that description, and based on the present rules of magnetism and electricity.

We may now say that for some years past we have been compelled to think that at least one of the fundamental rules of magnetism and electricity was wrong; because it is, if not in contradiction, at least in non-accordance with other well-known phenomena of Nature.

These reflections have led us to try something other than the present rules exclusively would suggest, and so have enabled us to avoid the mechanical difficulties stated before, and we believe with full success.

First we have made a very small dynamo for the purpose of justifying our reasoning, and on it giving the expected results, we have made a 200-H.P. dynamo for the purpose of testing efficiency, &c.

At an early date we hope to give you a full description of the dynamo and of our experiments, and also, so for as we can, its theoretical explanation.

As soon as we are clear with our patents, we shall be very pleased to show one of our commutatorless dynamos in our Birkenhead works, to any competent person applying by letter.

We shall also issue a pamphlet, pointing out the advantages of our new dynamo in its different applications, and we will send same free to those desiring it.

We shall put that dynamo on the market under the style:—

De Puydt and Poncin's Continuous Current Commutatorless Dynamos and Motors.

M. Poncin.

February 5th, 1897.

[We do not know of any mechanical difficulties in the way of a commutatorless continuous current dynamo, we

imagined they were electrical. It is a pity our correspondents have not thought fit to correct that fundamental rule of magnetism and electricity; think of the numbers of students who have been turned out of the various technical schools with wrong notions! Lastly, why go to the expense of constructing a 200 H.P. machine, when one a tenth of that power would have sufficed?—Eds. Elec. Rev.]

Telephone Trunks.

Le condensateur shunté a été intercalé dans le circuit de la ligne pour le seul bien du télégraphe. Il n'a rien de commun avec le système Van Rysselberghe, auquel il n'ajoute aucune propriété nouvelle ni dont il ne détruit aucune qualité existante. La capacité et la résistance sont établies de manière que $C R^2 = L$, d'une façon grossièrement approximative. $C = 10$ microfarads; R varie entre 3,000 et 3,500 ohms, d'après la longueur du conducteur et la quantité plus ou moins grande de fer entrant dans sa construction.

Le condensateur shunté se trouve adapté à une installation de relais-translateurs intercalée sur un circuit desservi par appareil Hughes; son rôle consiste à empêcher la production des "kicks" auxquels donne lieu l'extra-courant engendré dans le circuit entier, et principalement dans les électro-graduateurs.

Il ne m'a pas été donné d'expérimenter la capabilité de transmission, au Morse, d'une ligne de l'étendue indiquée par M. Gavey et constituée par un fil de fer de 4 m/m. La chose n'a, au surplus, aucune importance dans le cas qui nous occupe, le point que nous souhaitons voir élucidier étant simplement le suivant: Pourquoi le condensateur shunté qui annule l'action de la self-induction des graduateurs—puisque les kicks disparaissent—ne gène-t-il pas la communication téléphonique, en rendante les signaux du télégraphe perceptibles dans le téléphone, alors que le principe même du système Van Rysselberghe semble être détruit?

J. Pierart.

Bruxelles, *le 27th Janvier*, 1897.

Electrical Engineers and the Record Reign.

Permit me to send a copy of a letter which I have addressed to the President of the Institute of Electrical Engineers.

S. Flood Page.

102, St. George's Square, S.W.
February 8th, 1897.

Dear Sir,—Scientific electricity, as we now know it, is essentially a product of her Majesty's reign, while commercial and industrial electricity have had their rise in very recent years. No more important application of science to industry has been achieved during her Majesty's reign than that which we are witnessing day by day in the application of electricity to effect work in many forms.

This being so, I venture to address you, as the President of the Institute of Electrical Engineers, to suggest that the above facts form sufficient ground for united action on the part of the whole of those connected with electricity, whether in its scientific, commercial, or industrial aspect, in supporting the appropriate effort of his Royal Highness the Prince of Wales to relieve the hospitals of London from their burden of debt, and to place these most useful and valuable institutions on a sound financial footing. I beg, therefore, to suggest that you should convene a meeting of all those who are engaged in any branch of electrical work in the metropolis, whether with cables, telegraphs, telephones, light, or traction, and that, as our President, you will place yourself at the head of this movement, with a view to enlisting the hearty co-operation of all electricians in assisting this proposed fund, for if we can avail ourselves of the present effort to place the hospitals of London on a sound financial footing, we may rest assured they will remain permanently and be of the same great advantage to future generations as they are now, and have been in past years.

I am impressed with a strong belief that if you would initiate such a movement, and will give the influence of your high official and personal position, in support of the proposal of the Prince of Wales, electricians of all ranks will subscribe a sufficient annual amount as to repay your efforts, and to manifest their liberality and loyalty. The wages classes already prove their interest in our hospitals by the amount they collect for the Saturday Hospital Fund, and I hope that arrangements will be made, not only for annual subscriptions of pounds, but also in our electrical workshops and central stations for annual subscriptions of one or more shillings.

I trust that, as this is a matter of public interest, you will pardon my sending a copy of this letter to the electrical Press, as well as to the Chairman of the Electrical Section of the London Chamber of Commerce.

I remain, dear Sir, yours faithfully,
S. Flood Page.

Sir Henry Mance, President of the
Institute of Electrical Engineers.

Re Electrical Cabs.

Your clever and lucid article on the above subject in to-day's issue of your Journal will be interesting to many people, and I think a good many like myself will be interested to know the details of the working of the Johnson-Lundell controller referred to.

You described at some length the controllers of the same firm in use at Dublin and Bristol; but I hardly think the same design is applicable to single motor cabs.

Cabless.

February 5th, 1897.

Kosmo Wiring.

Your editorial comments and your correspondent's remarks upon the Kosmo concentric wiring appear to be criticisms based upon a very casual acquaintance with the characteristic features of the system.

It is well known that for equal sectional areas of conductors and equal insulation, a concentric cable is somewhat more expensive than two separate insulated conductors, but this difference is fully compensated in the Kosmo system by the saving in cost of wood casing or conduits, and by the facility the cables afford for rapid erection and consequent saving in labour.

The fact that the aggregate sectional area of the outer conductor in the smaller Kosmo cables is twice that of the inner, is not an extravagance, inasmuch as in most installations of electric lighting, limitations in fall of electrical pressure and also mechanical stability determines the sectional areas of conductors to be used, rather than considerations of current density; thus in double wiring, cables in the smaller sizes are used of double or treble the sectional area required to meet the well known 1,000 ampere to the square inch rule.

It thus appears that on the score of weight of copper in the conductors, the Kosmo cables are not more extravagant than cables on the double wiring systems, the distribution being easily arranged so that the largest percentage of the fall of pressure allowable shall take place upon the inner conductors, the fall upon the outers being very small indeed.

Again, as the illuminating power of a glow lamp decreases at an extremely rapid rate as the electrical pressure falls, it is sound policy in every case to put ample copper in the small conductors. The commercial soundness of this practice, from a lighting point of view, has been amply demonstrated, notably by Professor Ayrton.

Running conductors on the surface of walls is a system not to be advocated, but it is often a convenience in old buildings, and where cost is an important consideration, hence the hitherto extensive use of wood casing on the surface of walls, which compares badly in point of neatness and adaptability with a small lead-covered cable placed immediately beneath the moulding, and coloured to match the walls.

Kosmo cables, covered by steel U-shaped troughing, beneath the plaster, and with the joint boxes brought out to the surface, is at once a cheap and efficient method of wiring in new buildings, when it can be carried out during erection.

Your correspondent laments the fact that "a disadvantage this method of wiring . . . labours under is the fact that, once installed, the capacity of the supply is fixed and limited," and later on remarks that "a comparison of the above system with a conduit system shows that this latter has decided advantages in respect of later convenience, although its first installation may present greater inconvenience."

If your correspondent were writing upon the subject of electrical distribution for a town supply these remarks would have great significance and weight, as the ultimate requirements in such cases are vague and difficult to forecast, but in a building the ultimate requirements can be readily ascertained and provided for, which provision only affects the size and capacity of the larger mains, and these, even in the case of a well designed conduit system, are always put in large enough for the ultimate demand.

The writer has yet to learn of any case where, after the installation has been set to work, the cables have had to be drawn out of the conduits to make room for larger ones. The operation does not appear to be a very simple one, by reason of the number of joints and connections involved, and it would be exceedingly interesting to know what the

difference in cost would be between putting in the large cables at the first outset and substituting larger cables for smaller ones at a later stage with its inevitable inconvenience, the cutting and remaking of joints, the "scrapping" of old wire and the cost of labour involved.

I trow that the first method would be in every case the most sensible and cheaper proceeding. A little consideration will show that this much vaunted drawing out of networks of conductors from metallic conduits is not the cheap and simple operation generally supposed, and, with good work in the first instance, this removal is not necessary; consequently, in almost every instance, metallic conduits arranged for the drawing in and out of distribution networks are an unnecessary and expensive refinement.

Geo. Wilkinson.

Communication between Coast and Light-Ships.

The general tenor of your article of December 25th, entitled "Communication between Coast and Light-Ships," unfortunately conveys the erroneous impression that the experiments made by Prof. L. M. Blake in conjunction with the U.S.A. Lighthouse Board were original, whereas you will find from the following particulars of the operations at the Needles and the Fastnet that he has not priority in the initiation and application of the non-continuous conductive system.

In 1886, the late Mr. Willoughby Smith gave his attention to the subject of communication between light-ships or lighthouses and shore, and as he had previously made a special experimental study of some of the electrical phenomena relating to induction and conduction, he naturally turned to those experiments for assistance.

His first idea was to make use of induction, but previous experiments indicated that the sea water between the sending and receiving coils would, by reason of its conductivity, absorb a large proportion of the energy, the percentage of energy absorbed depending upon the conductivity and thickness of the interposed mass, and the frequency of the alternations or interruptions of the primary current.* This phenomenon is evidently the cause of the failure of Mr. Evershed's recent experiment at the Goodwin light-ship. Mr. Willoughby Smith then considered the question of conduction, and proposed to use the sea water itself as part of the circuit. After several preliminary experiments in a fresh-water canal, he carried out a successful and conclusive experiment at Great Yarmouth in May, 1887, the light-ship being represented by a small boat placed at some distance from the shore. The method then initiated has since been considerably developed and modified, and is now familiar as the non-continuous conductive system.

Owing to serious illness, Mr. Willoughby Smith was unable to continue his experiments, and the matter remained in abeyance until Sir Edward Birkbeck moved for the appointment of a Royal Commission to enquire into the whole question of communication with lighthouses and light-ships.

This motion, and the subsequent appointment of the Commission, revived the subject, and in May, 1892, with the assistance of Mr. Granville, who has been throughout identified with the work, I carried out the Needles experiment on behalf of the Telegraph Construction and Maintenance Company. In reference to your remarks as to these experiments, I would again point out, as explained in the *Times* and elsewhere, that they were made for the special purpose of demonstrating to the Royal Commission, and also to the Trinity Board, that the system was perfectly practicable. This object having been accomplished, the experimental cable was removed, after having worked satisfactorily for many months. In October, 1892, I gave evidence before the Royal Commission, and in their first report they recommended that the system should be employed at the Fastnet, one of the most exposed and inaccessible rock lighthouses in the world.

The work at the Fastnet was commenced by the Telegraph Construction and Maintenance Company in the middle of July, 1895, when the Postal Telegraphs ss. *Monarch* laid the cable from Crookhaven to the vicinity of the Fastnet, but the lateness of the season prevented its completion that year; for at the Fastnet, even in summer, work at or near the water's edge can only be carried on at comparatively rare intervals, and in winter the base of the rock is inapproachable. For the purpose of making a double "earth," we found it to be necessary to bolt two cables down the almost vertical sides of the Fastnet rock. These short lengths of cable were secured as well as opportunity and the lateness of the season allowed, but it was impossible to secure them to the rock below or even at the water's edge; and in consequence, during a winter gale, one of these "earth" cables was twisted off at a point just below the lowest fastening. Notwithstanding this occurrence, telegraphic communication was daily maintained throughout the winter.

The main cable from Crookhaven terminated in the vicinity of the Fastnet in a length of 80 feet of unarmoured cable, the end being connected to a copper mushroom anchor, which served as a mooring for the cable and an "earth" for its conductor; and in March, 1896, it was found that this unarmoured portion had broken off immediately at the shank of the mushroom anchor. On picking up and carefully examining the unarmoured cable, it was abundantly clear that the break had been caused by the repeated to and fro bending action of the tides, and that the cable had not been in any way injured by the action of the waves. To obviate the difficulty of maintaining the rock "earths" near the water's edge, I decided to drill a 2½-inch diameter hole through the solid rock on each side of the Fastnet, the slope of the hole being so arranged that its lower end emerges far below the low-water mark; this work was successfully completed, and the heavy copper rods for insertion in the holes for use as "earths," and a new mushroom, together with its terminal length of extra strong cable, have been ready since June of last year. Unfortunately, H.M.T.S. *Monarch* was unable owing to work elsewhere, to proceed to the Fastnet during the summer, or the whole system would long since have been in full working order. The delays that have occurred are certainly not greater than might have been expected, considering that the first permanent application of the system is to the Fastnet, and therefore an extremely difficult undertaking.

The original patent for the non-continuous system was taken out in 1887, and in 1893, together with Mr. W. P. Granville, I patented an improved and modified method, practically identical with the patent granted one year later to Prof. Blake, the only difference in my opinion being that, whilst both patents claim the application to light-ships and lighthouses, Prof. Blake's specification contains a drawing of a light-ship, with the cable attached to the mooring chain, whereas in our own specification the system is shown as applied to a lighthouse.

A few months ago you were kind enough to give your readers an opinion in reference to these two patents, your conclusion being that the use of a telephone, as claimed by Blake, was not covered by our own patent, which speaks broadly of telegraphic signals. Without accepting your verdict as being correct, it would be interesting to know under which denomination you would place the "call," for in either case some form of "call" apparatus is absolutely necessary.

During the summer of 1892 advantage was taken of the opportunity afforded at the Needles to make many experiments, and an attempt was made to obtain telephonic speech, but the result was not encouraging, for, although by the use of transformers, microphones, and telephones of low resistance, spoken words could be heard, yet the reproduction was much too faint, even under favourable circumstances, to allow of any practicable use, especially in situations where feeble sounds would often be smothered by the noise of the wind and sea. Again, since our lighthouse was also intended to represent a light-ship, an experiment was made in which one end of an iron chain was connected to the terminal mushroom "earth" of the cable, and the other end of the chain was taken to the lighthouse, but without any material benefit arising.

Other experiments followed, but ultimately discarding both chain and telephones, we confined ourselves to the work of perfecting the instruments for giving visual signals, such signals being, I believe, well suited for the purpose required, especially as modern lightkeepers are acquainted with the Morse code.

The only means which Prof. Blake appears to have tried differing from our own experiments, are the so-called "larger

* See *Journal* Institution Electrical Engineers, November 8th, 1883, also *Proceedings* of Royal Institution, June 6th, 1884.

diffusion or electrified area" method, and the partial insulating of the mooring chain by means of a bituminous paint.

Prof. Blake's first practical experiment was at Woods Holl, a small and almost land-locked harbour on the Massachusetts coast. The end of the cable was connected to the mooring chain, and he obtained good results which, however, I think were due to the shallowness and extremely limited area of the water, as well as the short distance of the ship from shore and not from any advantage derived from the use of the chain. Encouraged by this result, Prof. Blake attempted to obtain the same effect at the *Scotland* light-ship off Sandy Hook, but failed because of, as he is reported to have stated, the "entirely different conditions, the depth and density of the water being much greater, and instead of one mile from the shore as was the case at Woods Holl, the *Scotland* light-ship was four miles distant."

Under these circumstances, he coated the mooring chain with an insulating bituminous paint, and thus partly converted the non-continuous into a continuous cable system. This, of course, could at best be only looked upon as a very temporary expedient, quite useless for any permanent practical purpose; and Prof. Blake appears to have ultimately abandoned it.

When applying the non-continuous system to a lighthouse, we find that we get the best results by keeping our "earths" of fairly small dimensions, so as to concentrate the action to that portion of the sea which is in the immediate vicinity of the "earth" plate or mass of the other circuit; but in the case of a lightship which is ordinarily free to move over a circle of about 200 yards radius, we should, of course, alter the dimensions and form of the cable "earth" so as to meet these conditions, or, in other words, diffuse the action over a larger area.

When in America in May, 1893, I explained the particulars of the Needles experiment to Captain Mahan and the officers of the U.S.A. Lighthouse Department, and found that the method, which was novel to them, aroused a considerable degree of interest. I also pointed out that the arrangement might be of use in time of war, since a cable could be laid out to sea, with the end of its conductor attached to a mushroom anchor, so that any ship knowing the position of the submerged end could communicate with the shore by merely lowering, in the vicinity of the mushroom, a short length of insulated cable having the bared end of the conductor attached to a copper weight, using our special apparatus for giving visual signals and "call."

My object in writing you at this length is not to detract in any way from the value of the work carried out by Prof. Blake in connection with this difficult problem, but to show that, as far as possible, we had previously tried and discussed the methods he has used, and that in consequence it is hardly just to praise as novel the experiments carried out by the United States Lighthouse Board.

I am still confirmed in my opinion that, although a more or less satisfactory result could be obtained on a light-ship by means of our non-continuous system with visual signals, yet the best plan is a continuous cable as at present used, even if the cost of repair is high. For rock lighthouses the non-continuous system has been proved to be absolutely certain and steady in its action, but not with a telephone as a receiving instrument.

Willoughby S. Smith.

February 2nd, 1897.

BUSINESS NOTICES, &c.

Alleged Theft.—A youth named Thorpe is remanded at Sheffield on a charge of stealing 1 cwt. of electric cable from the premises of the Sheffield Electric Light and Power Company. There are also other charges against Thorpe.

Announcements.—To meet the requirements of their greatly increasing trade, the Midland Electrical Wire Company, of River Mills, Leicester, are more than doubling their plant, and have secured the services of Mr. Walter Levi, late of the Northern Electric Wire Company, to take over the management of the covering department for bell, electric light and instrument wires, &c.

Mr. Alfred Roberts (architect), who designed the Chelsea Electricity Supply Company's new station buildings, announces that his practice having extended, he has now taken more convenient offices at 18, Nelson Street, Greenwich, S.E.

Electrical Wares Exported.

Week Ending Feb. 2nd, 1896.	£	s.
Adelaide	6	0
Albany. Teleg. mat. ...	730	0
Alexandria	25	0
Algoa Bay	191	0
Amsterdam	50	0
Auckland	33	0
Bangkok. Teleg. mat.	315	0
Bombay	58	0
Brussels	26	0
Buenos Ayres	176	0
Cape Town	110	0
„ „ Teleg. mat.	27	0
„ „ „ cable	7,200	0
Delagoa Bay	39	0
East London	585	0
„ „ Teleg. mat.	762	0
Flushing	81	0
Hong Kong	198	0
King Georges Sound ...	76	0
Liban	43	0
Melbourne	668	0
Otago	152	0
Port Natal	434	0
Reval	237	0
Rio Janeiro	3,404	0
Santande. Teleg. mat.	19	0
Santos. Teleg. insts. ...	124	0
Singapore	26	0
Sydney	250	0
Wellington	156	0
„ Teleg. mat.	880	0
Yokohama	85	0
Total	£17,166	0

Week Ending Feb. 2nd, 1897.	£	s.
Adelaide...	150	0
Alexandria	29	0
Amsterdam	55	0
Bombay	263	0
Buenos Ayres	22	0
Calcutta	333	0
Cape Town	256	0
„ „ Teleg. mat.	221	0
Colombo	18	0
Copenhagen. Teleg. mat.	35	0
Demerara. Teleg. mat.	113	0
Durban. Teleg. mat. ...	243	0
East London	3,133	0
Freemantle	12	0
„ Teleg. mat.	2,965	0
Gothenburg	18	0
„ Teleg. mat.	146	0
Hamburg	225	0
Launceston	21	0
Melbourne	1,400	0
„ Teleg. mat.	709	0
Ostend	30	0
Port Elizabeth	519	0
Rangoon...	33	0
Reval	90	0
Saigon	98	0
Shanghai	105	0
Singapore	64	0
Stockholm. Teleg. mat.	209	0
Sydney	1,002	0
Tientsin	25	0
Wellington. Teleg. mat.	971	0
Yokohama	508	0
Total	£14,021	0

Foreign Goods Transhipped.

Alexandria	£9	0

Electrical Wares Exported.

Week Ending Feb. 9th, 1896.	£	s.
Adelaide	15	0
Alexandria	187	0
Algoa Bay	69	0
„ Teleg. mtl. ...	335	0
Amsterdam	160	0
Bombay	12	0
Brussels	279	0
Buenos Ayres	637	0
Calcutta...	29	0
Christiania	9	0
Colombo	11	0
East London	135	0
Flushing	52	0
Fremantle. Teleg. mtl.	1,625	0
Hamburg	1,446	0
Melbourne	461	0
„ Teleg. wire ...	775	0
Port Natal	159	0
Rockhampton	77	0
Rotterdam	10	0
Stockholm. Teleg. mtl.	46	0
Sydney	166	0
„ Teleg. mtl. ...	523	0
Welllington. Teleg. mtl.	361	0
Total	£7,579	0

Week Ending Feb. 9th, 1897.	£	s.
Aden. Teleg. cable ...	10,080	0
Albany	221	0
Antwerp. Electric fuses	226	0
Bangkok	55	0
Bombay	41	0
Calcutta	76	0
Cape Town	89	0
Colombo	198	0
„ Teleg. mtl. ...	61	0
Demerara. Teleg. mtl.	18	0
East London	1,117	0
Gibraltar. Teleg. mtl.	36	0
Gottenburg	20	0
Hong Kong	110	0
Meroyne. Teleg. mtl.	27	0
Monte Video	30	0
Passages	155	0
Port Elizabeth ...	453	0
Rio Grande De Sul. Teleg. mtl. ...	40	0
Syra. Teleg. mtl. ...	34	0
Rangoon. Telep. mtl.	18	0
Revas	120	0
„ Teleg. mtl. ...	206	0
Shanghai	55	0
Singapore	78	0
Wellington	206	0
Yokohama	31	0
Total	£13,801	0

Annual Dinner.—The first annual dinner of the Birkenhead staff of the National Telephone Company was held on Saturday evening, at the Ranelagh Hotel.

Change of Address.—Mr. F. L. Rawson announces that on and after the 9th inst., his London address will be Brook House, 10, Walbrook.

Deed of Assignment.—A deed of assignment for the benefit of creditors has been executed by Thomas Percival Pollitt, of 19, Teneriffe Street, Higher Broughton, Manchester, and Samuel Heap, Eversleigh, Rochdale, trading as Whittaker, Pollitt & Co., electrical engineers, 18 and 20, Blackfriars Street, Salford. The trustee under the deed is Mr. Arnold Watson, accountant, 39, Piccadilly, Manchester. The unsecured liabilities are returned at £1,769, and the assets, after deducting the claims of preferential creditors payable in full, amount to £1,788.

Doulton Ware Electric Light Fittings.—The Edison and Swan United Electric Light Company is issuing a circular of statuettes, brackets, &c., made of Doulton and Doulton Holbein ware, adapted for electric lighting. This class of ware seems to lend itself well to artistic design for such purposes. We understand that the Edison & Swan Company are the sole agents for statuettes and fittings made of Doulton ware.

Bankruptcy Proceedings.—On February 1st, on a creditor's petition, a receiving order was made at the Manchester Court in *re* C. L. Clarke, electrical engineer, carrying on business at 7, South Parade, Manchester, as the Northern Counties Electric Construction Company.

William Reginald Ridings, of Albert Street, Birmingham, electrical engineer, and late of Fair View, Bristol Road, Birmingham, was, says the *Birmingham Post*, adjudicated a bankrupt a few days ago by Mr. Registrar Glaisyer.

Liquidation Notices.—A general meeting of the Southampton Electric Light and Power Company will be held on March 8th at 3 o'clock, at 23, High Street, Southampton, for the purpose of showing the manner in which the winding-up has been conducted, and of hearing the report of the liquidator, Mr. J. T. Hamilton.

According to a notice in Tuesday's *London Gazette*, the Thetford Electric Light and Power Company, Limited, decided, at a meeting held at Thetford on February 1st, to wind up voluntarily, as the company cannot, by reason of its liabilities, continue the business. Mr. H. P. Gould, of Norwich, was appointed liquidator.

The liquidator (Mr. H. E. Sherwin Holt) of Swinburne & Co., Limited, announces in the *London Gazette* that a meeting of the company will be held at 66, Victoria Street, S.W., on March 10th, at 12 o'clock noon, for the purpose of having an account of the winding-up laid before it.

Franklin v. The Exeter Electric Light Company.—In the Chancery Division of the High Court, on Saturday, before Mr. Justice North, Mr. Jenkens mentioned the case of Franklin *v.* The Exeter Electric Light Company, which came on for hearing or further consideration. Learned Counsel stated that the company was formed for the purpose of supplying the town of Exeter with electric light, and it appeared that previous to the commencement of the action, which was by the debenture-holders, the Corporation of Exeter had entered into an agreement with the company for the purchase of the whole of their undertaking. Judgment was given in the action, and an order was made to realise the security comprised in the debentures. A receiver was appointed, and the usual accounts were taken. A subsequent order was made directing the receiver to pay the money coming to his hands to the debenture-holders instead of paying it into Court. The Corporation of Exeter had now paid what was due from them under the contract to purchase, and it was asked that the receiver, after paying what remained in his hands to the debenture-holders, should be discharged, after paying what should be found due for costs. His Lordship directed accordingly.

Gas.—Toward the end of last week, gas explosions occurred at Benyon Road, N., and Wroughton Road, Wandsworth Common. In both instances persons on the premises were injured, and damage done to property by fire, &c.

Early on 9th inst., a disastrous gas explosion occurred at Martha Road, Victoria Park.

An escape of gas resulted in the wrecking of some Norwich premises, and several persons were seriously injured.

On Saturday last, a gas explosion occurred at Waverley Station, Edinburgh, and injured two men who were engaged removing an old gas tank.

Lists, Calendars, &c.—A new illustrated price list (36 pages) of electrical apparatus has been issued by Messrs. Cox-Walkers, of Darlington. Telephones, fire alarms, electric bells, electric motors, and the various accessories for such apparatus, also galvanometers, switches, batteries, &c., are illustrated and priced.

From Messrs. Ernest Scott & Mountain, Limited, we have received an exceedingly neat calendar. There are several small illustrations showing some of the heavy electrical machinery manufactured by the firm, and above the calendar slips is a full width and very effective reproduction from a photograph of a battleship under steam. The design of the calendar is very artistic.

Messrs. Davies, Kent & Stewart, manufacturers of electrical accessories, &c., of Heddon Street, Regent Street, W., have issued a convenient pocket price list of electrical fittings, wire, &c., and calendar for 1897.

Messrs. Easton, Anderson & Goolden, Limited, have issued a catalogue describing some of the machinery and plant of which they make a special line. Water works and pumping engines, turbines, lifts, cranes, Grafton high speed engines, boilers, pneumatic machinery, pulverisers, electric mining plant, &c., are among the machinery illustrated and described. Of electrical interest, there are a number of items, such as pumps driven by electric motors and dynamos, electric lifts, electric travelling cranes, electric coal cutting, signalling, lighting, and traction machinery. The book is well printed and illustrated, bound in stiff brown covers with gilt lettering.

From the Edison & Swan United Electric Light Company we have received a copy of their new fittings catalogue (Section III.). The book has nearly 200 pages, and contains illustrations and details of as many as 350 articles. An early page contains a list of licensees under the company's holder patents. We cannot afford space to more than briefly mention some of the specialities shown in the catalogue, much as it deserves lengthy notice. We observe, of course, Ediswan lampholders of various patterns and descriptions, counterweights, wall plugs, and sockets, a number of styles of pendants, brackets, portable hand lamps, and other fittings for use in connection with ship lighting. Switches of all types are much *en evidence*, particularly tumler switches, single pole, double pole, and triple pole change-over chopper switches, regulating switches, and accumulator charge and discharge ditto. For outside lighting, such as shop window illumination, there are various fittings included, ceiling roses, cut-outs, switchboards, and a quantity of other accessories being also shown. Page 159 contains a description of Neville's patent automatic accumulator switch, the object of which is to prevent battery current discharging through the dynamo, when for any reason the E.M.F. of the dynamo falls below that of the battery. This has several pages devoted to it, and instructions and diagram for fixing are given. The catalogue is nicely printed, set out, and illustrated, good paper being used.

Messrs. J. Hopkinson & Co., Limited, of Huddersfield, have sent us a pamphlet dealing with their improvements for the safer working of connected steam boilers and blow-off valves. Prices and sketches are given of the firm's patent isolating valves, parallel slide blow-off valves, &c.

Messrs. B. Egger & Co., of Wien, have sent us a list, printed in German, describing, pricing, &c., electric bells, telephones, and various small electrical accessories.

The Consolidated Telephone Construction and Manufacturing Company, Limited, has issued a new illustrated price list of No. 101 transmitters, along with a number of testimonials *re* same.

Messrs. W. B. Haigh & Co., Limited, of Oldham, have sent us price lists of their ammeters and voltmeters and main switches, also illustrated lists of standard patterns of dynamos and electric motors as manufactured by them. There is a large number of tables giving detailed information as to output of dynamos in kilowatts, and of motors in brake horse-power.

London Agency.—Messrs. David Joy, Son & Pryor, of 85, Gracechurch Street, E.C., have been appointed London representatives of Messrs. J. P. Hall & Co., electrical engineers, of Oldham, and that in future all the firm's London business will be conducted through them.

Micanite.—Mr. A. Norman writes as follows with reference to our "Business Notice" on "Mica," in our January 29th issue:—"With reference to the paragraph in last week's Review *re* 'Micanite.' Speaking from a practical armature winder's point of view, I cannot see how it is possible to rewind an armature without re-insulating it, after being burnt up in the manner you describe. Of course, it is impossible to burn mica, but all the other material that goes to make the micanite would be burned up, and as these materials are the means of making the mica adhere to the core, therefore there would be nothing to hold the pieces of mica together and on to the core." If the writer will again refer to the note in question, he will find that the description is not ours, but is a copy of a testimonial given by the Schenectady Railway Company.

Personal.—We understand that Mr. E. George Tidd, Ass.Mem.Inst.C.E., Ass.Inst.E.E., has severed his connection with Messrs. Paterson & Cooper, and his address will in future be—c/o Messrs. Morris, Warden & Co., 25, Gordon Street, Glasgow. Mr. Tidd has been on Messrs. Paterson & Cooper's staff for upwards of 10 years, and has designed and carried out many of their most important installations. Four years ago he was appointed manager of their Northern Department, with head offices at Glasgow, where he had the sole superintendence and management of all contracts in Scotland, and North of England and Ireland.

Smoke Nuisance.—The Liverpool Electric Supply Company were summoned at the Liverpool Police Court the other day for causing a nuisance by the emission of an excessive quantity of smoke. A fine of £5 and costs wan inflicted.

ELECTRIC LIGHTING NOTES.

Alderley Edge.—The question of the transference of the electric lighting order to Mr. S. V. Clirehugh and the Alderley and Wilmslow Electric Supply Company was again under consideration at the District Council's last meeting.

Ayr.—The Council has agreed to proceed with electric lighting extensions, and £15,000 is to be borrowed for new works.

Belfast.—The electrical engineer has been instructed to visit a few towns in England with a view of obtaining information relative to steam-driven electric lighting plant, similar to that proposed to be laid down here.

Colchester.—We understand that the Town Council last week accepted the offer of the Electric Construction Company to work the electric plant for two years, the Company, on receiving the payments for current, to pay the Corporation £800 per annum for interest on capital and sinking fund. The Company estimate that although there will be a loss on the first year's working, there will be a profit on the second year—enough, and more than enough, to reverse it.

Colwyn Bay.—The District Council having advertised for schemes to light the district by electricity have received schemes from the following competitors:—Messrs. G. Adams, Taylor & Field, and W. G. Walker, three Westminster firms; Messrs. F. F. Bennett, Fawcus & Clirehugh, Booth, Chadwick & Porter, and George R. Peers, all of Manchester; T. W. Baker, London; James Duce, Deganwy; J. S. Highfield, Stafford; Kingsland, Edwards & Tasker, Llandudno. As the Council are anxious that an impartial successor should consider the schemes, they have desired each competitor to send to the surveyor the name of a person who will act the fairest in the matter, and the expert who receives the greatest number of nominations will be appointed to report to the Council as to the merits of the various schemes.

Croydon.—It is said that the public arc lamps have been giving some trouble, and that some alterations may be necessary.

Brighton.—The Town Council, at the last meeting, considered the report of the Lighting Committee, who presented a report from Mr. Arthur Wright, electrical engineer (published in last week's ELECTRICAL REVIEW), and recommended that the initial charge of 7d. per unit for an average of one hour per lamp per day be continued, and that the charge for electricity over such average be reduced from 3d. to 1½d. per unit. Alderman Bolling regretted that the Committee had not seen their way to the reduction of the charge of 7d. for the first hour per day, thinking that it was most unnecessary and very unfair to many. He calculated that the annual cost of the undertaking was £17,348, and that a charge of 2½d. per unit would bring in £21,096, making a profit of £3,758. He moved as an amendment, that the charge of 7d. per unit per lamp for the first hour be discontinued, and a uniform charge of 2½d. be made to all customers. In opposition, it was stated that the cost of the first hour's lighting was 8½d. per unit, so that there was actually a loss in working, and it was submitted that a person ought not to expect to get the same advantage by using the light for one hour as another who used it 12 hours a day. After a discussion the amendment was withdrawn and the report adopted.

Cheltenham.—On Saturday evening the Mayoress switched on the arc lamps which have been placed in the High Street, Clarence Street, and St. George's Place, as a first instalment of the public lighting of Cheltenham by electricity. The ceremony took place in the Council Chamber, Alderman Norman presiding.

Consett.—At the meeting of the District Council last week the special committee appointed to consider the question of lighting the town by electricity reported that the cost of the latter illuminant at Witton Gilbert was £1 5s. per lamp, while at Consett they were paying over £2 per lamp for gas.

Dundee.—The amount collected in electricity rentals for the nine months ending January 31st, shows an increase of £595 12s. 9d., the amount received for the nine months up to January 31st being £3,360 5s. 3d. Gas shows a decrease of £939.

Edinburgh.—Mr. Newington, the resident electrical engineer, and his staff, are at present very busily engaged in changing over the consumers from the 115 volt system to the 230 volt pressure.

Elland.—There is a strong feeling on the part of many members of the District Council that it would be wise for that authority to take up Councillor Sydney Thornton's proposition, and establish electricity works. Reports are now being obtained by the District Council as to the suitability of various premises for electricity works.

Godalming.—The electric lighting question has several times been under consideration here, and we understand that the Council now favours the introduction of a scheme.

Harrogate.—The Town Council has adopted a recommendation of the Gas and Electric Lighting Committee to the effect that Mr. Geo. Wilkinson be appointed electrical engineer and manager of the electric lighting undertaking for one year from the date of opening.

Killarney.—We understand that the Council will shortly be advertising for gas and electric lighting tenders.

Kingswood.—The purchase of the electric lighting undertaking (Parfitt system) from the Western Counties Electric Light and Power Syndicate, Limited, will probably be completed shortly. The syndicate shareholders have agreed to the Kingswood Council's offer; but a loan will have to be raised by the Council, and a Local Government Inquiry held, after which a time will be fixed for the completion. It is likely that the Council will go thoroughly into the question of lighting the district, as other towns have done, when the electric lighting undertaking has been taken over, and a suggestion has been made for the question of improvements, extensions, &c., to be investigated before the inquiry is held, and so avoid the necessity for a second such inquiry.

Leeds.—The Lamp Committee of the Leeds Corporation are contemplating lighting the principal thoroughfares in the central parts of the city by electricity. They propose to place arc lamps on the poles that are to be used to support the overhead wires for the electric tramways. It has also been suggested that the requisite electrical current for lighting should be obtained from the central generating station at Crown Point.

Leyton.—At the last District Council meeting, Prof. H. Robinson made a statement giving the approximate total expenditure in connection with electric lighting. The total amount was £24,764 8s. 5d. They had already borrowed £16,850, leaving a balance of £7,914, and it was now necessary to borrow £6,000. Mr. Jennings thought the Council had gone far beyond what was anticipated. They had not benefited one farthing by the electric light.

Lincoln.—It is understood, says *Daily Tenders*, that estimates will shortly be wanted for engines and boilers for the electric lighting station.

Liverpool.—At the last meeting of the Lighting Committee of the City Council, it was reported that the maximum daily output from the electric supply stations in December, 1896, was 18,350 amperes, compared with 13,600 amperes in December, 1895, the increase being 34 per cent. Under these circumstances, the Committee approved of the electrical engineer's proposal to increase the boiler power at the Paradise Street station. It was also decided, on the recommendation of the superintendent of street lighting, to place four electric lamps on the plateau in front of St. George's Hall.

Liverpool.—The Electrical Engineer has been authorised to fit up for electric lighting the City Hospital (North Extension), and the Port Sanitary Offices, at a cost of £317 and £22 respectively.

Manchester.—The City Council had electric lighting matters under consideration last week. Alderman Gibson, chairman of the Gas Committee, called attention to the proceedings of the Electric Light Sub-Committee containing a resolution to seek borrowing powers to the extent of £65,000 for engines, dynamos, and some structural alterations in Dickinson Street station, and to borrow £50,000 for the extension of mains to the districts of Fallowfield, Plymouth Grove, Stockport Road, Hyde Road, Oldham Road, and Rochdale Road. Practically, he said, the Committee were asking to borrow £130,000. Referring to the past history of the electric light undertaking, he said that in 1892 they borrowed £80,000, and in 1893 £70,000, which enabled them to produce electric energy quite sufficient for 40,000 8-C.P. lamps. This they considered would probably be as much as would be required for the next three years. But the demand for the electric light still continued to increase rapidly. In 1895 the Committee borrowed £100,000, which was expended in further extension of the electric light. Still this was not sufficient, and in 1896 they were compelled to borrow £100,000, and the result was that to-day they had a producing power equal to 128,000 8-C.P. lamps. There were connected with the works 136,000 8-C.P. lamps, so the Committee were in the position that if all the customers wanted the light simultaneously, there would be 8,000 more lamps than the station could supply. That was not all. They had obligations to-day for 9,956 extra lamps, which were not yet connected. In 1895, after paying interest and sinking fund and all working expenses, they made £5,000 profit. In 1896, after paying interest, sinking fund, and all expenses, the profit amounted to £11,000. At the expiration of the present financial year in March, 1897, it was extremely probable that the electric light department would be quite as successful this year as last. So he thought it would be admitted that, although they had spent a good deal of money, it had been spent wisely and well. As to the future of the electric light, he would be a bold man who would venture to foreshadow it as regarded Manchester. He believed there was no finality about it. The Council had undertaken to supply the whole of the city with electricity. There were all sorts of conditions they were going to apply electricity to. There were electric motors and tramcars, and it was impossible to say what electricity would be applied to in the city. The capital account of the electric light department would have to be reckoned not by hundreds and thousands of pounds, but by millions of pounds. The undertaking would become as great as the gas undertaking, which at present was represented by millions of pounds. The Committee had applications every day for the electric light for all sorts of appliances, and for engines of all descriptions, big and little.—The proceedings of the committee were approved, and it was resolved that application be made to the Local Government Board for their sanction to the borrowing of a further sum of £130,000 for the purpose of the electric light undertaking of the Corporation.—It was resolved to advance the salary of Mr. Wordingham, the electrical engineer, by £100 each year for the next four years, beginning March next, provided that Mr. Wordingham enters into an agreement to remain in the employ of the Corporation for a period of four years from March next, and devote the whole of his services thereto in acting as resident electrical engineer, and carrying out any electrical extensions in the future as required by the Corporation.—Alderman Gibson explained that there were special circumstances in the case. Mr. Wordingham had received a *bonâ fide* offer of £1,000 a year to take a position elsewhere. He had done excellent work for the city, and in the electric light installation of Manchester would be a monument which would stamp him as one of the foremost electrical engineers of the country. The Corporation paid Dr. Hopkinson £4,700 for his advice upon the electric light installation in the first stage. Twice the number of engines had been put up since then under Mr. Wordingham's supervision and advice, and he had not been paid a penny extra for it. If it had not been for that gentleman the Committee would have had to pay another £4,000 for advice, and by agreeing to the recommendation the Council would secure one of the most competent engineers.

Mile End.—We understand that the Guardians last week decided to accept the tender of the Thames Ironworks Company for lighting their premises electrically at a cost of £4,926, notwithstanding the recommendation of the committee, which was that the contract be given to Mr. A. L. Fyfe at £4,137 10s.

St. Pancras.—The Vestry has decided to extend its mains in Park Village West, Regent's Park, in response to applications.

Shoreditch.—The Vestry had a discussion the other day regarding the best system of keeping accounts in connection with the electric light undertaking. The idea of going to Brighton to see the Wright system in practical operation was ridiculed by several members, and eventually the matter was referred back to the Lighting Committee.

St. Saviour's.—The St. Saviour's Board of Works recently instructed a committee to consider the question of electrically lighting the streets in their district. Their report has been submitted, the cost being shown at about £11,000 per annum, and the Board decided not to undertake the lighting.

Sunderland.—The estimated expenditure in connection with the electric light for the half-year ending March 31st, 1898, is £1,354, and the revenue £2,696. A gross profit is shown of £1,342, but after deducting payments for interest and sinking fund charges, the estimated net profit is only £242 16s.

Tonkin.—A company with the title Société d'Electricité de Saigon, is about to establish a central station at Saigon, Tonkin. The plant will consist of three De Laval steam turbines and dynamos of 150 H.P. each.

Tunbridge Wells.—The borough electrical engineer (Mr. Boot) has furnished us with the following facts regarding the progress of the electric lighting since the opening of the electric lighting works in October, 1895. An electrical exhibition held the same week was a thorough success. It showed a clear profit of £100, and added a number of consumers. There were then 47 consumers with a total of 1,300 lamps, exclusive of public lighting. At December 25th, 1895, there were 117 consumers with 5,056 lamps. The number of units for the first quarter was 16,340. By the quarter ended March 25th, 1896, there were 144 consumers with 6,968 lamps, the number of units sold being 20,284. For the quarter ending June, 1896, there were 162 customers, with 7,581 lamps, the number of units sold being 13,185 (light quarter). For the quarter ended September, 1896, there were 186 customers, with 9,200 lamps, the units sold being 25,769. For the quarter ended December, 1896, 207 customers, 10,066 lamps, units sold 61,991. The number of consumers on the register on February 1st, 1897, was 214, with 12,065 lamps connected. The financial year ends March 31st, 1897, which is the first complete year's running. During that period the Council has applied for an additional loan of £12,000, and at the last Council meeting, a further loan of £15,000 was applied for. Before all the original machinery was completed, the demand was sufficient to overload it, and they are now in the same position again. With the loan agreed upon at the last meeting, it is proposed to extend and develop the works; £4,000 is to be spent on cables this year. More public lamps will be lighted and mains extended wherever the demand is considered sufficient. Since the opening of the station, two new steam alternators and three new boilers have been put in, and specifications are now being prepared for a new 350 kw. alternator and condensing plant. This is a very satisfactory showing.

Upper Norwood.—The Croydon Corporation, having unsuccessfully endeavoured to enter into negotiations with the Crystal Palace District Gas Company for the supply of incandescent gas burners to the street lamps in the district of Upper Norwood, which are served by the company's mains, have communicated with the Crystal Palace Electric Lighting Company, with a view to substituting electricity for gas.

Wakefield.—The Guardians have decided to advertise for tenders for electric lighting and power, telephones, electric bells, &c.

Walsall.—The Electric Lighting Committee reports that the accounts of the first complete year's working of the electricity department—viz, to December 31st—showed that the total expenditure (exclusive of interest and sinking fund) was £1,130 7s. 9d., and the total income £1,568 7s. 6d., leaving a surplus of £437 19s. 9d. to be applied to interest and sinking fund, which together amounted to £883 3s. 7d., thus making the net total deficiency in respect to the year's working £445 3s. 10d. In the first quarter they made a loss of £44, in the second one of £277, and in the third one of £188, whilst in the fourth a profit of £62 was made.

Whitechapel.—The District Board has considered the offer of the County of London and Brush Company to take over its provisional order, and referred the matter to a committee.

York.—Prof. A. B. W. Kennedy, consulting engineer to the Corporation on the question of lighting the city by electricity, has presented his report to the committee, and a special meeting of the Council was held on Monday to consider the subject. In his report, dated January 7th, Prof. Kennedy states the amount of the tenders received for the various sections of the work, and adds that in his report of February last, he gave the probable outlay for plant and mains as £12,000. The totals for Sections A and B—which cover this work—amount to £11,252, so that the estimate covers ample allowance for contingencies and additions in connection with the cables and roadwork, which are priced to schedule, but the exact quantities of which cannot be settled beforehand. The schedule prices for the first hundred services and meters come to £695, so that his allowance of £1,000 covers ample margin. Eight firms tendered for Section A, namely: The India-Rubber Works, Silvertown; Messrs. Siemens Bros. & Co.; Messrs. Johnson & Phillips; Messrs. Greenwood & Batley; the Electric Construction Company, Limited; Thomas Parker, Limited; Messrs. Crompton & Co., Limited, and the Brush Electrical Engineering Company, Limited. All these firms tender to specification, and several of them give alternative tenders according to the maker of the engines tendered for. The lowest tender is that of Messrs. Crompton & Co. The next lowest is that of Messrs. Siemens, with Belliss engines, and the next that of Messrs. Johnson & Phillips, with Willans engines. "The only question in my mind," says Prof. Kennedy, "is as to the most advantageous of the four alternatives submitted by Messrs. Crompton, which differ only as to the proposed makers of the engines. I have tested the Davey-Paxman engine (Peache's patent), and found it satisfactory on test. I do not personally know the Browett & Lindley engine, but believe that this firm are good engineers, and they undertake to work to specification in every respect. No doubt Messrs. Belliss & Co., and especially Messrs. Willans & Robinson, have greater experience in this class of work; but considering the standing of the firm tendering, I think you need not hesitate in this case to accept Messrs. Browett & Lindley as Crompton's sub-contractor. If you do this, the amount of the contract will be £8,176, which, with £307 for the electrical pump, makes a total of £8,483." For Section B (mains) there were seven tenders, namely, India-Rubber Works (Silvertown), Messrs. Siemens, Messrs. Henley, the British Insulated Wire Company, Messrs. W. T. Glover & Co., Callender's Cable Company, and the Fowler-Waring Company. Prof. Kennedy recommends the lowest, which is that of Messrs. Callender. For Section C (arc lighting) there were nine tenders, viz.: The India-Rubber Works, Silvertown; Messrs. Siemens Bros.; the Brockie Pell Company, Limited; the International Electric Company; Messrs. Drake & Gorham; the Davy Electrical Company; Callender's Cable Company, Limited; Messrs. Crompton & Co., Limited; and the Brush Electrical Engineering Company, Limited. The two most important tenders, says Prof. Kennedy, are those of Messrs. Crompton (the lowest) for their own lamps, and Messrs. Drake & Gorham for Jandus lamps. Prof. Kennedy asks the Corporation not to decide *re* this section until he has completed tests he is now making of these lamps.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Austria.—During the next two years the Cracow Tramways Company will construct five new overhead conductor tramways in Cracow and suburbs.

Belfast.—The report of the Belfast Street Tramways Company, just issued, says:—"With regard to the question of electric traction, it will be remembered that Parliament has granted power to use electric traction, but subject to the sanction of the Corporation being first obtained. The directors are fully alive to the advantages of electric traction, and have done their best to make terms with the Corporation. The Corporation have, however, declined to sanction the use of electric traction except upon terms which are absolutely prohibitive, and which it is quite impossible for the directors to accept. The question of electric traction is, therefore, owing to the action of the Corporation, completely at a standstill."

Cardiff.—A committee has been appointed for the purpose of considering the advisability, in the public interest, and for the convenience of the public, of establishing a system of electric tramways in various parts of the borough. The proposer of the appointment of a committee showed that the tendency was to adopt electricity as a motive power. His idea was that electric lines should be laid along Castle Road to Roath Park, from Temperancetown into Cathedral Road, and along Clifton Street to the East Moors, and he thought it would mean an immense revenue to the Corporation in supplying electricity. The special committee was constituted of the Mayor, Aldermen D. Jones and Jacobs, the Deputy Mayor, and Councillors Evans, Tucker, Crossman, Robinson, F. J. Beavan, Good, H. Jones, Allen, Andrews, and Hallett.

Crewe.—By 13 votes to 7 the Crewe Town Council has decided not to oppose the application for an order to construct light railways in Crewe by the British Electric Traction Company. The Council had already inspected the Coventry and Walsall electric tramway systems.

Crosby.—Mr. Holme, of Messrs. Holme & King, railway contractors, Liverpool, has been in communication with a committee regarding electric tramways through the district. Mr. Holme has submitted a plan of the route, but the Council before giving the matter further consideration wants to know the method of working the tramway.

Dover.—The contract with the electric light company for the supply of electrical energy to the tramways to be put down by the Corporation has been sealed. The Tramways Committee has invited tenders from several firms for the supply of the electrical equipment, and these were to be considered by the committee, under advice from Mr. Sellon, the tramway engineer, last Tuesday.

Electric Lighting and Tramways.—The Highways Committee recommended the London County Council that they should be allowed to submit to the Board of Trade a clause for the protection of the Council's tramways in the matter of laying electric lighting mains, and to ask that such clause be inserted in all electric lighting orders which might be granted in this and future years. This was agreed to.

Hull.—The Tramways Sub-Committee received tenders from the following, says *Daily Tenders*, in connection with the re-construction and leasing of the Hull street tramways:—Mr. Nettleton, Hull; A. Dixon & Co., Birmingham; Gas Traction Company, New General Traction Company, British Electric Traction Company, Thomson-Houston Company. The consideration of these tenders has been adjourned for a fortnight.

Proposed Praed Street-Willesden Railway.—The engineers to the West Suburban Railway scheme have deposited their estimates of the cost of constructing the railway as proposed in the Bill of the present Session. The scheme, according to the *Financial Times*, comprises a double line, commencing at Praed Street and following the course of the Grand Junction Canal, to Acton Lane, Willesden. The total length of the line will be 4½ miles, and the cost of construction is put down at £296,992. In this estimate is included a sum of £20,000 for stations, and £86,995 for the acquisition of the necessary lands. It is proposed to work this railway by electricity.

Rochdale.—The Bury, Rochdale, and Oldham Tramway Company has made an application to a committee to run their tramcars to Littleborough by electric instead of steam engines, and they also wished to have another lease of 21 years granted to them. A sub-committee visited Walsall, Bristol, and Coventry to inspect the systems of electric traction existing in those boroughs, and the majority were well satisfied with them. A report is being prepared.

Liverpool.—The Liverpool District Lighting Company, Limited, has written to the Waterloo District Council, stating that the company had long seriously considered the idea of adding to their lighting undertaking the construction of a tramway, the motive power of which would be electricity, from Seaforth Sands Station of the Liverpool Overhead Railway through Waterloo and Crosby. The company would be willing to undertake the construction and working of such a tramway if they could be assured of the support of the local authorities of Waterloo and of Great Crosby. They would propose that the mode of traction should be by means of cars driven by accumulators in the body of the car from electricity generated in their present station at Waterloo. The tramroad would be a single line with turn-outs, and the company would be willing to extend all the arrangements with the local authorities as regarded electric lighting to the arrangement for the tramways, so that the local authority would have the option of taking them over at the same time as they take over the electric light. The company would be very glad to meet the Council and discuss the terms with a view of going for an order at the earliest opportunity. The Simplex Electric Tramway Conduit Syndicate, Limited, also sent a letter to the Waterloo Council enclosing a prospectus giving a rough sketch of the Simplex system of electric traction. The letter stated that a short length of line was now being constructed at Prescot, and would be completed in a few days, when those interested in the subject would have an opportunity of inspecting the line. The matter was referred to a committee.

Middlesbrough.—On the 27th ult. a special meeting of the Town Council was held, for the purpose of considering the proposed substitution of electric tram-cars for the horse-car system at present running in the borough. The meeting was convened on the requisition of eight members, who were of opinion that it was desirable to obtain as early as possible additional tramway facilities for the borough as well as tramway communication with the adjoining towns and villages; and that for that purpose advantage should be taken of the application proposed to be made by the Imperial Tramways Company for a provisional order, in the ensuing session of Parliament, in order that these facilities may be obtained without waiting until the period arrives at which the Corporation has power to purchase the existing lines of tramways in the borough. Ald. Hugh Bell moved:—"That the assent of the Council be given to the application of the Imperial Tramways Company for a provisional order, on the terms which have been offered by the secretary to the company, as embodied in his letter of January 5th, subject to such modifications as may be hereafter agreed upon, and specially of purchasing from the company the lines within the borough, if they should so desire, at some earlier date than is provided by the General Tramways Act, 1870." The meeting adjourned consideration for a week.

Sheffield.—A deputation appointed to go into the question of electric traction has issued a very exhaustive report recommending the adoption of the overhead electric trolley system in Sheffield, making a beginning on the Nether Edge and Attercliffe sections, with connecting lines into Fitzalan Square. The committee visited a great number of towns at home and in Continental countries. The report covers 120 pages, and contains about 20 illustrations.

Stockton.—It has been agreed, provided proper clauses were inserted in the provisional order to provide for the concessions offered to the Corporation, that the application of the Imperial Tramways Company to convert the present steam system into an electrical overhead trolley system should be assented to by the Council.

Thornaby.—At a special meeting of the Corporation last week, it was reported that various concessions had been made to Thornaby by the company promoting the scheme for the construction of an electric tram system from Norton through Stockton, Thornaby, and Middlesbrough; and the Council consented to the scheme. Mr. Robinson, on behalf of the company, said they hoped to introduce the best system that had been put down anywhere. It is the overhead trolley system, on the latest principles.

TELEGRAPH AND TELEPHONE NOTES.

Manchester Telephones.—A meeting of the supporters of the movement for supplying an independent telephone service in the Manchester district was held at the Chamber of Commerce there on 27th ult., Mr. T. T. Shann presiding. There was a large attendance. Mr. John Thomson moved the following resolution:—"That this meeting having heard the explanations given by the New Mutual Telephone Syndicate and the results of the canvass made by them, expresses its approval of their object in endeavouring to establish a competing telephone service, and that this meeting pledges itself to actively co-operate with the members of the syndicate in obtaining that object." He said each member of the syndicate was contributing £100, and they did not expect to receive anything but their own money back again. They were taking action for the simple reason that the National Telephone Company were using them very badly. He, for one, found it almost impossible to make use of the telephone, and after wasting a quarter of an hour with no other result than a loss of temper, he had generally to send a boy with the message. No doubt others had had the same experience. Things were a little better now; but what was the reason? No doubt the action taken by the syndicate had something to do with it. He was a believer in fair, reasonable competition, and if they could bring competition to bear in Manchester in regard to the telephone service they would improve things for everybody. Mr. G. C. Haworth seconded the resolution. He said his firm had subscribed £100 to the syndicate. The meeting would smile if he said they had done so from motives of philanthropy, and, as a matter of fact, he did not believe in philanthropy in business. Their reason for joining the movement was the difficulty and inconvenience they experienced at present in using the telephone. In the discussion Messrs. W. Thomson and Bennett (manager of the late Mutual Telephone Company), and others took part. The resolution was adopted. The Chairman remarked that of the two thousand necessary as a basis for the company, they had received promises from 441 persons, and 556 had promised to pay to the company half the amount of any reduction that might be made in the present tariff.

Misplaced Confidence.—During periods of political tension, when questions of moment require to be settled speedily: the telegraph plays an important part as a means towards this end; and for this reason it is necessary that entire confidence should be felt in this means of conveying important messages. This necessity it is, doubtless, which has indicated to H.M. Government the need of means of communication with her colonies which is not liable to be tampered with. The following extract from a *Times* telegram from Paris gives an instance of the small reliance which is to be placed on some of the existing telegraph lines as a means of transmitting messages of urgent importance:—"After all, however, this is but one side of M. Valfrey's article. He draws from the Dongola Expedition most unexpected conclusions. In the first place, he says that the expedition gave England an opportunity of casting a slight on France by concealing the plan from her while other Powers, less interested than France, were aware of it. This is a fallacy which has already been exposed. It may be affirmed that, but for an incident with which the French Government has the best reasons for been acquainted, it would itself have had due notice of the expedition, but the battle of Adowa suddenly occurred, and the King of Italy immediately sent cipher telegrams to the Emperor William and to Queen Victoria. The Queen was asked to make a diversion in the direction of Kassala, which might help the Italian army, and the Emperor was asked to use his influence with England. The telegram to the Queen was deciphered before it reached its destination, so, at least, persons usually well informed assert, and the French Government thenceforth knew that the expedition would be made, for it had not been in such entire ignorance of the preparations of Egypt as not to comprehend the result of King Humbert's telegram. The English Government, taken by surprise by the battle of Adowa and the steps thereby rendered necessary, immediately telegraphed to the Sirdar to set out, before there was time to announce the expedition officially to the Powers.—*Our Own Correspondent.*"

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1895 ...	...
West Indies—		
Puerto Plata-Martinique	Dec. 19th, 1895 ...	...
St. Croix-Trinidad ...	Nov. 30th, 1896 ...	...
Grenada-Trinidad ...	Feb. 4th, 1897 ...	...
Jamaica-Colon	Feb. 6th, 1897 ...	...
Delay to Trinidad and Demarara 12 to 15 hours.		
Amazon Company's cable—		
Parintins-Itacatiara ...	May 5th, 1896 ...	...
Obidos-Parintins ...	Dec. 7th, 1896 ...	...
Hong Kong-Macao	Jan. 5th, 1897 ...	...
Pernambuco-Ceara	Feb. 4th, 1897 ...	...
Emden-Vigo	...	Feb. 10th, 1897.
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Salisbury-Umtali	July 11th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...
Saigon-Bangkok	Feb. 2nd, 1897 ...	Feb. 6th, 1897.
Saigon-Bangkok	...	Feb. 10th, 1897.

The Pacific Cable.—Mr. A. G. Jones, one of the Canadian Commissioners at the Pacific Cable Committee, and Mr. Sandford Fleming, have returned to Canada. Mr. Jones stated that the Committee had decided to make nothing public until the report was submitted to the British and Colonial Governments by the chairman of the Committee. Mr. Jones added that he felt at liberty to state that the cable was found to be practicable, which fact was doubted previous to the appointment of the Committee. The Committee agreed unanimously on the report, and, in his opinion, it will be satisfactory to the various Governments. No difference of opinion, he added, existed as to the proposed route, and the cable will be an all-British one. Mr. Sandford Fleming stated that, from the character and weight of the evidence, he was convinced that the report cannot fail to sustain and confirm all that was said upon the subject at the Colonial Conferences of 1887 and 1894. He believed, says the *Colonies and India*, that all the essential points had been fully met, and the cable, beyond dispute, shown to be practicable, while the cost will be moderate, and that the cable will be of immense value to the commerce of Canada and the rest of the Empire. Mr. Fleming concluded by stating that, while the hostility which existed some time back to the project has not been withdrawn or been overcome in certain quarters, it is in a fair way to be broken down and rendered entirely harmless, and that the prospects for the early establishment of the important national work are very hopeful.

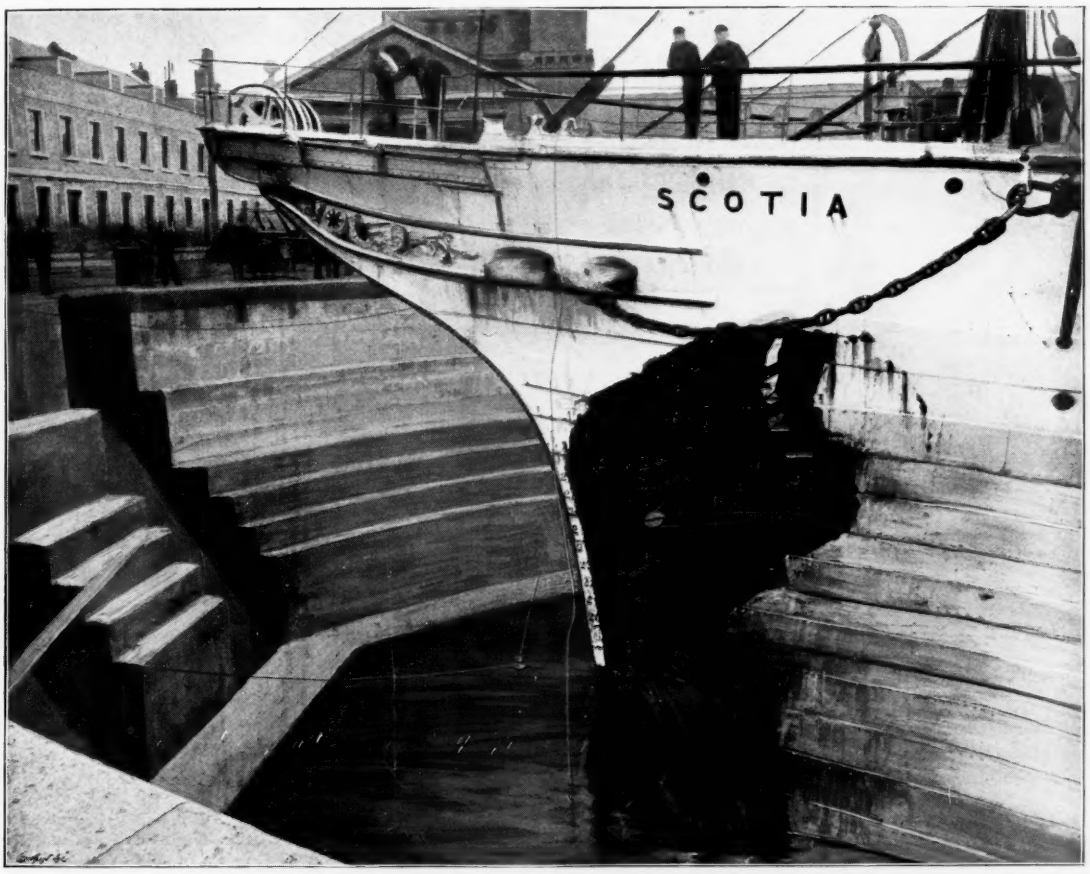
(*Telegraph and Telephone Notes continued on page* 215.)

THE EXPLOSION ON BOARD THE S.S. SCOTIA.

In our issue of October 23rd last, we briefly referred to a very serious explosion on board the Telegraph Construction and Maintenance Company's cable s.s. *Scotia*, which sustained very considerable damage.

The explosion was at the time assumed to have been caused by an inflammable vapour arising from some anti-corrosive composition, and the Board of Trade inquiry has shown the correctness of the assumption.

It is stated that about 1½ cwt. of "boot topping" composition was stored in the fore-peak of the *Scotia* in two kegs, one being filled. Then apparently some of the paint became upset, the petroleum spirit evaporating and mixing with the air, and so forming an explosive mixture. On the bo'sun of the vessel putting a lamp down the fore-peak hatch in an endeavour to discover a leak, an explosion took place, which brought away the shell-plating framework on



the port bow, 19 feet × 14 feet, and damaged the starboard bow over an area of 22 feet × 13 feet, besides injuring the collision bulkhead and various other internal portions of this proverbially unlucky steamer.

According to Dr. Dupré, one volume of the paint stored in the *Scotia* suffices to make 4,000 volumes of air inflammable, and there was sufficient petroleum spirit in one cwt. of the "boot topping" composition stored on the *Scotia* to give off enough vapour to render 5,500 cubic feet of air mixed with it a dangerous explosive mixture. The space in which the *Scotia* explosion took place was only 1,200 cubic feet, hence, less than one quarter of a cwt. of the composition would have sufficed to account for the damage occasioned.

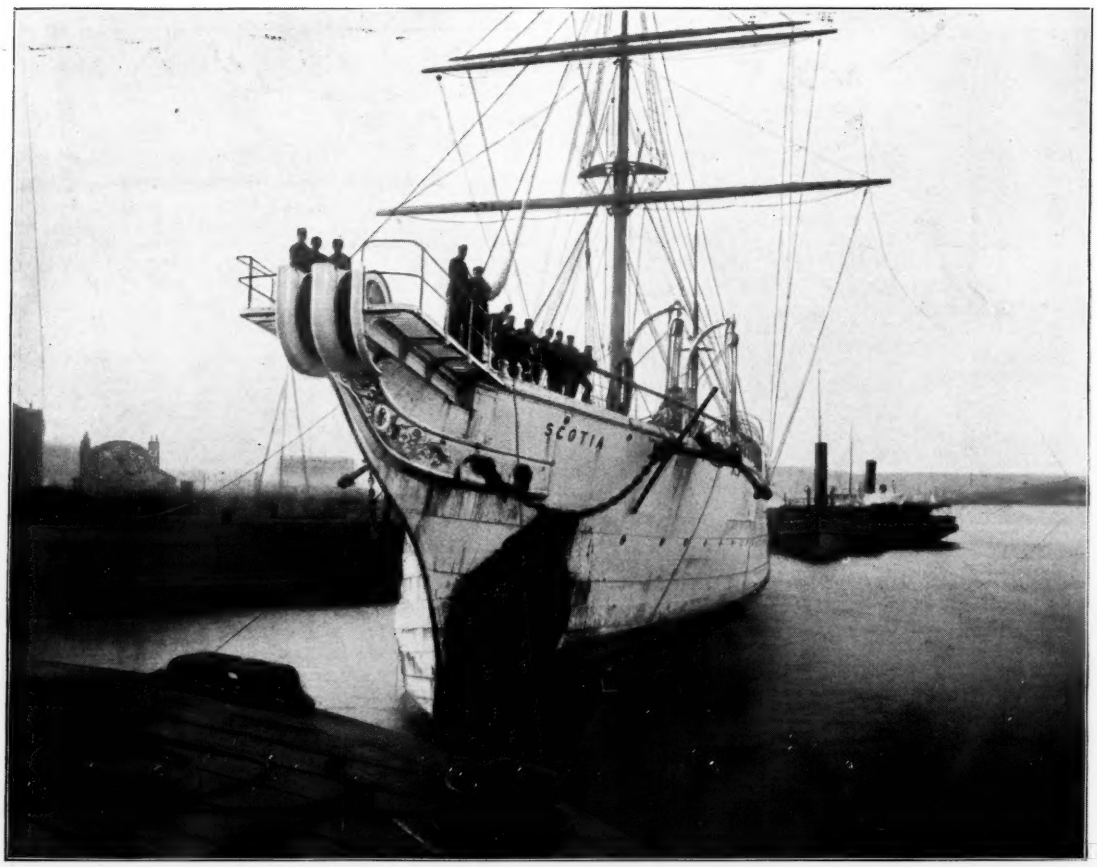
Through the courtesy of the Secretary of the T. C. and M. Company we are enabled to reproduce two photographs of the damaged vessel, which bear eloquent testimony to the effects of what a contemporary terms "gaseous vapour of almost incalculable explosive force."

TELEGRAPH RATES TO THE EAST.

A perusal of the report presented to the shareholders of the Eastern Telegraph Company at the last half-yearly general meeting, will show that this company has had a further increase to an already very considerable income. The chairman (the Marquess of Tweeddale) stated that the gross revenue for the half-year under review, to September 30th last, amounted to £435,465, showing an increase over that of the corresponding period of 1895 of £25,685. This increase was ascribed by the speaker to "exceptional circumstances," but as the accounts have shown a steady rise in revenue from the sum of £573,828 for the year ending March 31st, 1887, to £816,602 for the year ending March 31st, 1896, we can only conclude that exceptional circumstances, favourable to the shareholders of this company, are of annual occurrence. There can, in our opinion, be little doubt that recently the increase of revenue is, to a large extent, due to the augmentation of traffic which followed the reduction made by the Eastern Extension Telegraph Company in their rates to Australasia; a reduction equal to 50 per cent., which was made rather unwillingly, and only on condition that half the possible loss in receipts should be made good by the Governments of the Australian Colonies. A very few years experience in this case proved that, instead of a loss consequent on the lowering of the tariff, the annual returns not only exceeded those of the year 1889, selected as a basis, but yielded last year a sum of £104,673 (equivalent to an increase of 20 per cent.) over and above the year selected. In explanation of such satisfactory results exceptional circumstances were adduced. The financial crisis in Australia served as one reason; the development of Australian mines was also referred to, but no word was said about the advantage derived from the simple fact that the lessening of the cost had largely extended the use of the telegraph lines.

We are pleased to learn that the Eastern Telegraph Company has arranged for the reduction of rates in some instances. The tariff between England and Mauritius, and

the Seychelle Islands, as we have frequently pointed out, certainly required revision. It is satisfactory to know that a considerable reduction has been made, which will place this English possession, for communication with which such a large subsidy is paid by H.M. Government on at least a fairer footing than it has hitherto stood, when we consider the facilities which have been extended to Madagascar. While congratulating this company on such a step, we must express our regret that the chairman holds out no immediate hope of a reduction of rates to India. Concerning this subject, Lord Tweeddale points out that notwithstanding the reduction of 7d. per word made in 1886, no increase in Indian business has followed—that the traffic is practically the same in 1896 as it was in 1885, the year before the change above referred to was made. The lesson to be drawn from this seems to us to be an obvious one; the reduction made was evidently too slight. The immense volume of traffic with Australasia, which followed on the lowering of



telegraph rates made by the Eastern Extension Telegraph Company, teaches a lesson which should not be overlooked. Such a course might be tried with advantage in dealing with Indian communication. The present charge to India is 4s. per word, or only 9d. less than the charge to Australia. Now, if an increased volume of Australian traffic at these rates is beneficial to the Eastern Telegraph Company; bearing in mind that a portion of the 4s. 9d. is payable to the Australian landlines, and to the Eastern Extension Telegraph Company, which carries the message from Australia to Madras, it seems clear that in equity there is ample room for a reduction on the 4s. rate to India. Some time ago we drew the attention of our readers to a statement made by the late chairman of the Eastern Extension Telegraph Company, in 1890 (before the Australian rates were reduced), wherein it was pointed out that "the out-payments alone, without giving any return to the Eastern Extension Telegraph Company for its enormous system, amounted to 4s. 10d.;" at that time the rate per word from Australia was 9s. 4d., from which a deduction of the out-payments left 4s. 6d. to the account of the Eastern Extension Telegraph Company. Of this 4s. 10d. for out-payments, we understand that 8½d. was payable to the Australian landlines, and to Java, as transit tax, thus leaving a balance of 4s. 1½d. to be paid out per word, after a telegram from Australia to London had got as far as Madras. Should these proportions hold good since the rate to Australia has fallen to 4s. 9d. per word, it may reasonably be inferred (on the supposition that the Australian landline, and the Java transit, remain unaltered, which we believe to be the case), that a telegram from Australia to London, when it reaches Madras, is carried from thence to London for about 2s. per word; whereas on a telegram for London handed in at Madras, or any other part of India, the sum of 4s. per word is charged. We have no means of verifying the above figures, as unfortunately no information on the subject of out-payments is available since the rate to Australia was diminished.

Judging from the advantage which *both* companies acknowledge as accruing from the growth of Australian traffic; it would appear that some such agreement as that above indicated now exists; for it is absurd to suppose that since the reduction of rates to Australia the Eastern Extension Telegraph Company is content to receive as the proportion due to its "enormous system" only ½d. per word, instead of the 4s. 6d. which, as we show above, was received before the reduction. It seems also equally clear that by whatever increased amount (above ½d.), this company benefits, by just such amount has an Australian message reaching Madras in transit to London, the advantage in cheapness over a message of Indian origin. Another circumstance which supports our views is, that on the Indo-European Co.'s line, which works on a joint-purse agreement with the Eastern Telegraph Company, a message from London to Persia is carried for 1s. 6d. per word, which rate is in strong contrast with the 4s. rate charged by both companies for Indian messages.

We agree with the opinion expressed by Mr. E. O. Walker (late of the Indian Telegraph Department), who, when deal-

ing with this subject some time ago, said: "I venture to assert that in existing circumstances, looking at the dividends paid, the substantial reserves accumulated, the reduced cost of cables as compared with 20 years ago, and at the fact that the lines can carry a much larger traffic than they do, the public has a claim, and the companies and the Governments of India and this country have an interest, in making Anglo-Indian telegrams cheaper." We publish elsewhere, for the information of our readers, a statement of the very substantial and steadily increasing amounts received by the Eastern Telegraph Company. In the face of these figures it is difficult to accept the reason given to the Secretary of State for India as against a reduction of tariff, from which it seems that the company "did not consider that their financial position justified them in assenting to a reduction."

From a statement made by Lord Tweeddale concerning an item of £962 10*s.* for the use of patents, we learn that an automatic system of transmission is now being introduced on the cables to the East. It is anticipated that this will give a considerable increase of speed in the transmission of messages. We understand that the use of an efficient system of automatic curb transmission will increase the carrying power of the cables by from 30 to 40 per cent. The royalties payable are slight in comparison to the advantage gained, and as the chairman pointed out, the number of the existing staff is in advance of the immediate requirements. The company is thus in a position, at a very small expense, to make a new departure, and to deal with their Indian customers in a more liberal spirit, and we believe that by reducing the rate to India to 2*s.* 6*d.*, the ultimate increase in traffic would more than counterbalance any temporary loss. In any case it is very well worth while making the experiment which has produced such successful results as far as the development of Australian traffic is concerned.

RAWORTH "UNIVERSAL" TRIPLE EXPANSION ENGINE AND MORDEY INDUCTOR ALTERNATOR.

We referred in last week's issue to the tests in this plant, which we now illustrate, at the same time amplifying some of the particulars already given.

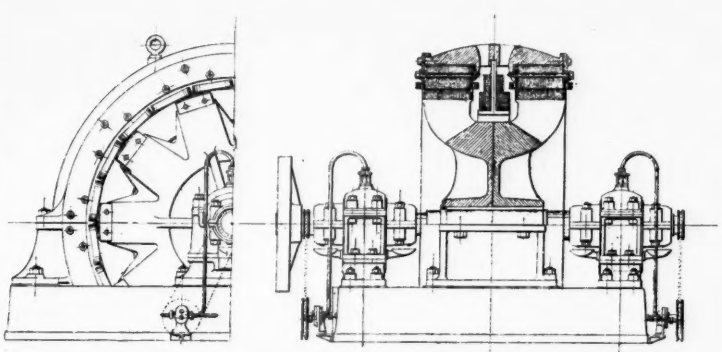
The engine is of 330-I.H.P. at 300 revolutions, triple expansion. It is of the single acting vertical type, with four cylinders arranged in pairs, tandem, the high and intermediate pressure on one crank, the two low pressure cylinders on the other crank; the cranks are set at 135° apart, the high pressure leading.

Dimensions of Cylinders.—High pressure, 16½-inches diameter; intermediate, 25-inches diameter; bolted directly to main standard. The low pressure cylinders are 25-inches diameter. The stroke is 10½-inches. The valves are of the Corliss type, four in number, 6-inches diameter, 2-feet long, their axes horizontal. They are worked by rocking levers, which are coupled directly to eccentric rods.

The speed control is by an automatic expansion fly-wheel governor acting on the high pressure cylinder. The very close governing and absence of hunting is a noteworthy feature of this engine.

A receiver of sufficient capacity to supply the intermediate cylinder is placed over the high pressure cylinder. The exhaust chamber of the intermediate cylinder, together with the pipes connecting the two systems of cylinders, is sufficient for supplying the two low pressure cylinders.

The lubrication is continuous, and is effected by means of an oil pump driven direct from the crank shaft.

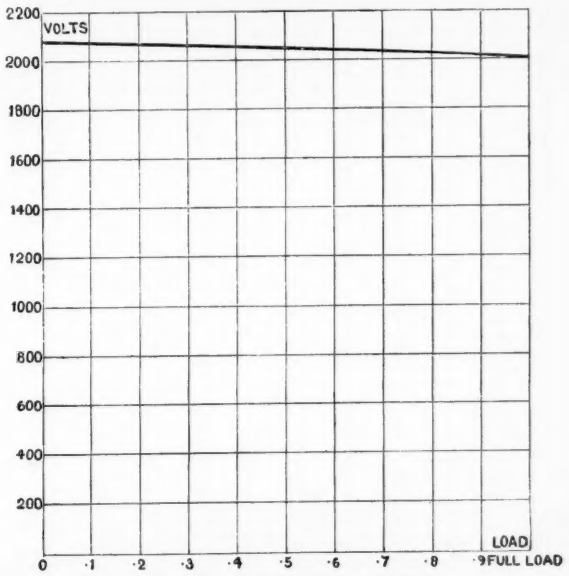


Mordey Inductor, Double Form.

Mordey's Patent Inductor Alternator.

Two forms of this type of machine are being introduced by the Brush Company, distinguished by having both the armature and field windings stationary, the rotating part (or rotor, as it is called) consisting of a solid casting with laminated projections.

The present illustrations clearly show the arrangement of the complete machine. In the single inductor type, which was fully described and illustrated in the Electrical Review for September 25th, 1896, from photographs taken during construction, there is one row (or ring), of armature coils, the rotor having projections at one end only. In the double inductor type there is a ring of armature coils



E.M.F. curve from No load to Full load.
Constant speed and constant excitation.

at each end of the machine, the rotor having corresponding projections at each end. The machine under test was of the single inductor type. The points to which attention is particularly drawn are these:—

Substantial form of machine generally. Absence of moving conductors. Safe position of armature windings, these being sunk in deep slots in the stampings, surrounded by ample insulating material. No collectors or brushes.

As regards the working of the machine, mention should be made of the following:—

Extremely good regulating qualities, the variation from no load to full load in the machine under test being less than 4 per cent. with constant excitation and constant speed. This result is considered to be the best that has ever been attained in any alternator, and is believed to be only a small fraction of the variation usual in iron alternators. The coolness of the machine is remarkable, there being hardly any perceptible warmth after long-continued running. The comparative silence during working is emphasised by the makers as a very important feature. The power required for exciting the machine is small—namely:—

At full load ... 1 per cent. of full output.
At half load ... ·75 „ „
At no load ... ·5 „ „

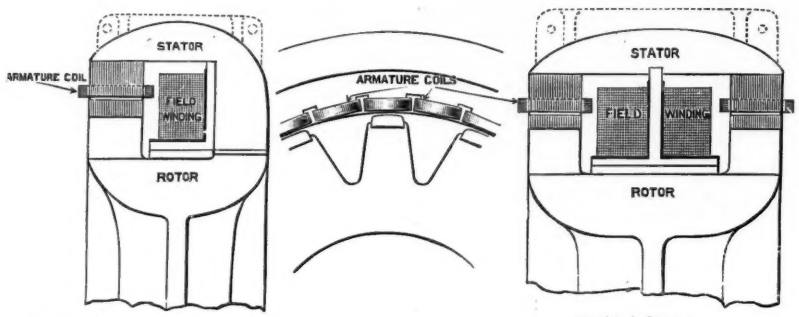
The machine under test worked at 50 periods.

The alternator has now been submitted to a number of

tests, and the results have been exceedingly satisfactory. We need not remind our readers that with iron alternators it has hitherto been felt that, whatever merits they might have, it has never been possible to claim for them that they were good regulators. So far as we know there is no iron alternator in the market that has a reasonably straight load characteristic. Wherever such machines are used in central stations the amount of attention required to keep the volts steady is said to be considerable, and it has not been thought possible to design an iron alternator that would keep its volts nearly constant when its load was varied rapidly and largely. Readers will probably remember that previous attempts to make alternators on the inductor principle have failed signally in the matter of regulation. Mr. Mordey has, as everybody knows, always made good regulation a matter of the first importance in alternators. The present machine, while having all the qualities that are required in the iron type, adds to them the claim of being the best regulating alternator of any kind whatever that has ever been run in this country. The load characteristic curves show that the variation is only a small fraction of that usual in iron machines, and it is interesting and satisfactory to learn that this result has been obtained without any loss of the qualities of safety, ability to stand short circuiting, and so on.

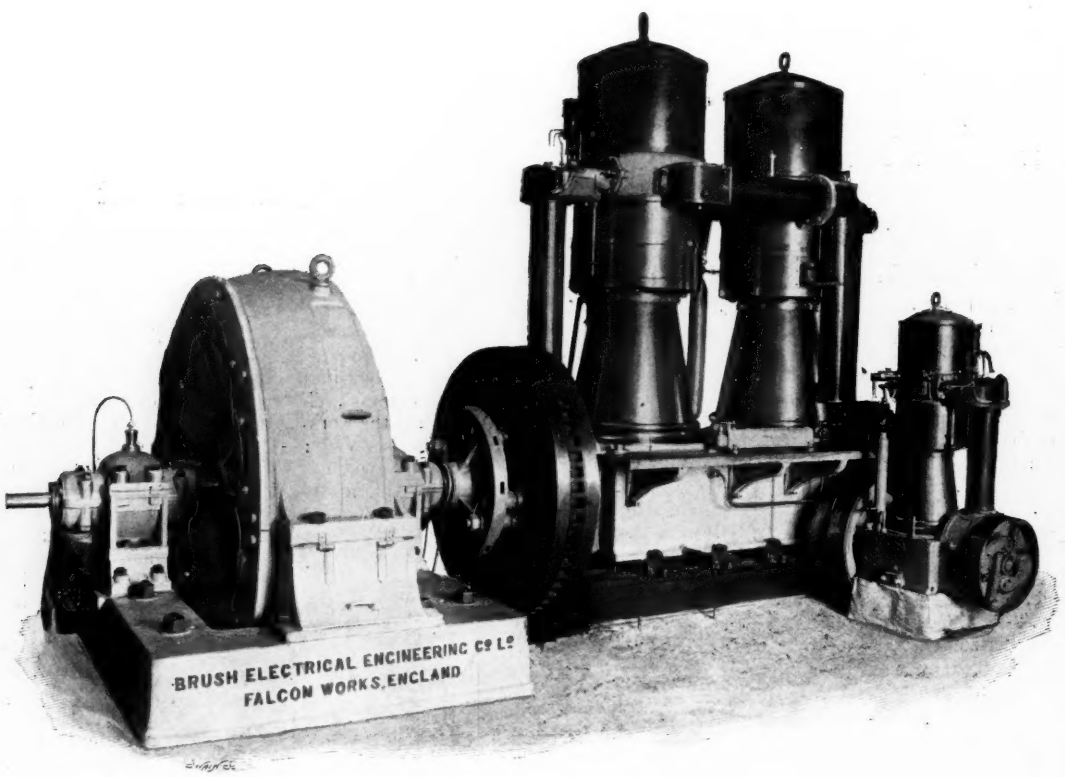
The Brush Company are, we think, justified in their claim that this machine is in an especial and striking degree simple and thoroughly mechanical, and that in its electrical qualities it is unapproached. The company intends to use this type of alternator for all its low periodicity work.

Boiler Tests.—We commented on Mr. F. L. Watson's remarks upon the Gosling test described in the *Engineer*. The Gosling people wrote in reply that the test was only to show what could be done with their furnace, and was not meant to show that the coal would do so much more, and so on. The Goslings evidently took the readers of the *Engineer* for geese, or they would have avoided making the reading so very ambiguous. Mr. Watson has himself found an improvement of 40 per cent. in certain cases, but not with the Gosling furnace, and we have seen very slight changes give hundreds per cent. of improved efficiency, and all genuinely obtained, too. It is an undoubted fact that all sorts of results can be made to show in fairly conducted tests by a suitable choice of leading data, such as grate surface, whereby the border line of efficient possible working may be either exceeded or just fallen short of the comparison obtained, but unless for private use and information, they are useless for publication.



Single inductor. Double inductor.

Diagrammatic Sketch.



TELEGRAPH AND TELEPHONE NOTES.

(*Continued from page* 210.)

The Eastern Telegraph Company.—An interesting analysis of the financial position of this company will be found in the *Investor's Review* for September last, from which we gather the following information:—The company is remarkably free from competition, as only two rivals touch its business to any important extent, these are the two landline systems owned by the Indo-European, and Great Northern Companies. In both these cases agreements exist with the Eastern, and the Eastern Extension Companies of such a binding character, that all the sting is taken out of their competition. The expenditure (paid out of revenue) on new cables amounts to £1,571,540, the reserve fund being given as £712,455, and for the last 15 years the dividends have fluctuated between 5½ and 6½ per cent., while for the last eight years the latter rate has been paid. This uniformity has, however, only been arrived at through the fact that all surplus earnings above the amount required to pay these dividends have either been placed to reserve or sunk in capital expenditure. The following figures show the amount of revenue, and the amount of profit after deducting expenditure for 10 years back:—

Year ending March 31st.	Revenue from messages, &c.	Revenue from dividends and interest.	Profit.
	£	£	£
1887	573,828	42,766	351,083
1888	597,159	53,076	402,467
1889	636,337	107,232	470,577
1890	661,624	111,654	484,007
1891	668,476	66,738	450,326
1892	670,084	66,189	425,844
1893	670,061	54,422	445,585
1894	702,813	55,164	467,013
1895	726,423	55,601	468,789
1896	816,602	58,361	558,293

With these facts before us it is hard to believe that the financial position of this company does not "justify them in assenting to a reduction" of the rate for telegrams to India, which is the subject of so much reasonable complaint.

The Telegraph Wire Export Trade.—The returns which are now available regarding the exports from this country of telegraph wire and apparatus connected therewith during last month show that there has not been anything like the activity which prevailed in December last. At the same time it will be seen that January last shows a larger total than has been recorded for the same month of the previous two years. To give the figures, the exports last month only amounted to £62,120, as compared with £118,720 in the preceding month; £57,224 in January, 1896, and £35,193 in January, 1895.

CONTRACTS OPEN AND CLOSED.

OPEN.

Ashton-under-Lyne.—March 15th. The Corporation want tenders for the supply and erection of refuse destructors, boilers, dynamos, transformers, cables, lamps, accumulators, &c. Consulting engineers, Fawcus & Clirehugh, Temple Chambers, Brazennose Street, Manchester. See our "Official Notices."

Fareham.—February 15th. The District Council want tenders for cables and conduits, for excavation, making good, and sundry house and public lamp connections. Consulting engineers, Messrs. Kincaid, Waller, & Manville.

France.—February 27th. The Seine Prefectural Authorities in Paris are inviting tenders for the concession for the electric lighting of the Broca Hospital during a period of 10 years. Tenders to the Prefet de la Seine, Tribunal de Commerce, Paris.

Germany.—February 20th. Tenders are being invited by the Altona Direction of the Prussian State Railways for the supply of 4,000 incandescent lamps and 179,000 arc lamp carbons required during the financial year 1897-98. Tenders to the Königliche Eisenbahn Direction, Altona.

Hastings.—February 15th. The Corporation is inviting tenders for the supply and delivery of 450 cast-iron ornamental standards. Particulars from Mr. P. H. Palmer, A.M.I.C.E., Town Hall, Hastings.

Islington.—The Vestry are inviting tenders for a year for the supply of various stores, &c. Item (11) is for the supply of manhole and other covers, &c., and ironwork; (14), supply of iron, steel and tools; (19), supply of electrical stores; (20), supply of engineer's stores. Further particulars may be obtained at the Vestry Hall, Upper Street, N., between 10 a.m. and 12 noon.

Jamaica.—April 15th. The Privy Council invites applications for a license for the establishment and working of a system of rapid transit in Kingston and environs. Copies of the Tramways Law, 1895, and of local rules and maps of Kingston and environs may be seen at the offices of the Crown Agents for the Colonies, London.

Spain.—February 23rd. Tenders are being invited by the Municipal Authorities of Tarragona for the concession for the electric lighting of the town during a period of 20 years. Tenders to be sent to El Secretario del Ayuntamiento de Tarragona.

Spain.—February 26th. Tenders are being invited by the Municipal Authorities of Villada (Palencia province) for the concession for the electric lighting of the town during a period of 16 years. Tenders to be sent to El Secretario del Ayuntamiento de Villada (Palencia province).

St. Pancras.—February 23rd. The Vestry want tenders for the supply and erection at King's Road Electricity Works, of two Lancashire boilers, feed pumps, steam pipes and accessories. Particulars obtainable at Electricity Department Offices, 57, Pratt Street, N.W. See our "Official Notices."

Wallasey.—February 18th. The District Council invites tenders for the supply and erection of a 200 kw. alternator with engine combined and for the requisite switchboard extensions. Particulars on application to the engineer, Mr. J. H. Crowther, the Great Float, near Birkenhead.

West Ham.—February 24th. The Corporation invite suggestions for free-wiring of premises in streets about to be provided with mains for the supply of electric light. Particulars from the electrical engineer, Mr. J. J. Steinitz, at the Town Hall, West Ham, E.

CLOSED.

Austria.—Messrs. Felix Singer & Company of Berlin have just secured a contract for the construction of an electric tramway between Kosir and Smechow near Prague.

Dewsbury.—The Board of Guardians has accepted the tender of Messrs. Dixon & Son of Leeds, to provide a new dynamo, and repair the present storage batteries at a cost of £158 less £33 allowed for the old dynamo.

France.—The French Post and Telegraph Authorities in Paris have placed the contract for 25 tons of bronze wire with the Usines Mouchel, Paris.

Poland.—The Allgemeine Electricitäts Gesellschaft of Berlin has secured a contract for the construction of an electric tramway on the overhead conductor system in the town of Lodz, Poland.

Dover.—The following is a list taken from the *Contract Journal* of the tenders which were submitted in connection with the Dover electric tramways for the construction of about three miles of the Dover Corporation tramways—single line with passing places—including a concrete road bed, the laying of rails, tie-bars, &c., and paving with granite setts, for the Town Council. Mr. H. E. Stilgoe, borough engineer:—

	£	s.	d.
J. J. Briggs, Blackburn (accepted)	9,729	14	1
E. Nicholls, Morecambe	11,594	17	1
H. Hill, Maidenhead	11,794	6	0
A. Brunton & Son, Hull	11,796	18	7
W. L. Meredith, Gloucester	12,470	15	10
W. Wadey, Stoke Newington	12,499	8	0
Dick, Kerr & Co., London	12,719	19	7
W. Griffiths, Kingsland Road, N.E.	12,738	3	9
J. Dickson, St. Albans	13,162	14	7
Pauling & Co., Ltd., Westminster	13,499	1	4
Callender's Cable & Construction Co., Cannon St., E.C.	13,570	13	0
Mowlem & Co., Westminster	14,688	16	4
C. Munro, Dover	14,820	0	0
Fry Bros., Greenwich	14,927	16	9

Engineer's estimate, £12,075.

For the supply and delivery of steel girder rails, fishplates, fishbolts, tie-bars, points, crossings, and other accessories for about three miles of the Dover Corporation tramways—single line with passing places—for the Town Council. Mr. H. E. Stilgoe, borough engineer:—

	£	s.	d.
Dick, Kerr & Co., London (accepted)	5,308	4	0
Rowell, Stuart, Kelman & Co., London	5,177	19	8
Pauling & Co., Westminster	5,186	0	0
Leeds Steel Works, Ltd., Leeds	5,730	10	0

Engineer's estimate, £4,900.

LEGAL.

The case of the Electrical Installation Company, Limited *v.* Armfield came before the Lord Chief Justice and a special jury in the Queen's Bench Division on Wednesday last. The plaintiff company carry on business in London, and devote particular attention to the installation of the electric light in country mansions, and having been consulted by Lord Stratheden and Campbell, of Hartrigge House, Roxburg, N.B., who wished to have an installation driven by water power, using for the purpose a burn, or small stream, which passed near the house, the plaintiffs, not being hydraulic engineers, consulted the defendant, Joseph J. Armfield, who carried on business at the Vale of Avon Works, Ringwood, New Forest, Hampshire, as a consulting hydraulic engineer and manufacturer of turbines, who agreed to go up to Scotland and report upon the efficiency of the water supply and the feasibility of driving the electric motor by water power. The plaintiffs' case was that the defendant reported that the water power, on the construction of a dam, was ample to drive a 6-H.P. engine, which the plaintiffs calculated would be sufficient power for an installation of 150 lights. The defendant reported further that the dam and reservoir necessary to produce a

head of water could be constructed at a cost of about £30, Lord Stratheden and Campbell finding the wood and labour. Thereupon, after Lord Stratheden and Campbell had consented to construct the dam and reservoir, the plaintiffs tendered for the work of installation, the total being £1,359, which included the cost of the turbine (£77) obtained from the defendant. The plaintiffs proceeded with the work, and did their part satisfactorily, but the construction of the dam and reservoir presented unexpected difficulties, and cost Lord Stratheden and Campbell £800; and even then the head of water proved wholly insufficient to provide the motive power required. Lord Stratheden and Campbell then refused to pay the plaintiffs' bill, and legal proceedings were taken, the result being that the plaintiffs had to compromise their claim for £750 and pay their own costs. The plaintiffs' case was that the whole difficulty was due to the defendant's negligence in making his report to the plaintiffs. The plaintiffs claimed £2,000 damages. The defendant denied negligence, said the work was not properly done, and that the damages claimed were too remote, and were not consequent upon any default of his.

Mr. M'Call, Q.C., and Mr. Crawford were counsel for the plaintiffs; Sir R. Reed, Q.C., and Mr. R. Bray for the defendant.

Adjourned for the day.

NOTES.

Borough Electrical Engineers and their Inventions.—Mr. G. Wilkinson, the borough electrical engineer of Harrogate, recently communicated to the Harrogate Traders' Association, a paper on the "Costs and Methods of Installing the Electric Light." The author makes some exceedingly sensible remarks on the necessity of obtaining good workmanship, and so on; but we question the wisdom of a borough engineer going out of his way to unreservedly condemn wood casing. We hold no brief for this method of wiring, but it cannot be denied that it has proved to be a most useful system in the past. It is in many respects inferior to a good conduit system, but if properly erected it will give no trouble, and although it may be eventually displaced by other methods, we cannot subscribe to the terms in which Mr. Wilkinson condemns it. The system, however, which does meet with the Harrogate engineer's approval is an improved concentric, and though it is not spoken of by name, there is little difficulty in identifying it with the Kosmo system, already described in these columns—which, moreover, is the invention of Mr. Wilkinson. It occurs to us that if Mr. Wilkinson carries out the principles laid down in his paper, he must prohibit wood casing in Harrogate; and as he considers concentric systems, other than his own, to possess defects, the only wiring that will meet with his approbation will be the Kosmo system. We do not seek to deny Mr. Wilkinson's right to insist, in his capacity of borough electrical engineer, upon the wiring in Harrogate being carried out in the best possible manner; but he must find some difficulty in judging of the merits, or otherwise, of systems of internal wiring whose principles are different to what he considers the best. Under some circumstances Mr. Wilkinson's position might involve him in being unjust to himself or unnecessarily hard upon contractors.

Prof. Waller on Animal Electricity.—Prof. Waller's fourth lecture on animal electricity was delivered at the Royal Institution, on Tuesday last. The lecturer confined his remarks to the effect of carbon dioxide upon the nerve. Carbon dioxide was the weakest of our anæsthetics, and Dr. Waller, by experiment and record, clearly showed the effect upon the nerve. It was of some interest to hear the lecturer say that, in deference to criticism, he used the word excitability instead of zincability. The latter portion of the lecture was devoted to a consideration of carbon monoxide.

On Electrical Terms Used by Physiologists.—It is necessary that we should rectify a clerical error that occurred in a note on this subject last week. The writer intended to say, "When injured, protoplasm goes a zincing; more or less, under anode or kathode." Which, being interpreted, means that protoplasm, when it has been injured, goes a zincing; or, as Dr. Waller would say, becomes "zincative," to a greater or less extent, according as it is under the influence of the anode or the kathode. It was never meant that the statement should derive adventitious importance from a metrical setting; but, of course, it was intended as a *reductio ad absurdum* of Dr. Waller's nomenclature.

The Metre Again.—If temper could settle the metric system for good or evil, our contemporary *Electricity*, of New York, should have done so. *Electricity* waxes very wrath with a recent opponent of the metre because he has stolen his opponent's own weapon. We are constantly hearing that the yard is only a distance on a metal bar, and that the metre is the 10-millionth of a meridianal quadrant. Mr. Colles, who now states that the metre, like the yard, is only a length marked upon a bar, is abused for doing so. We do not approve of Mr. Colles's following up of the arguments of Piazzi Smith, but we fear no amount of argument, however abusive, will ever make the decimal division of a standard length into a convenient system. If we are to have the metre, let us have it divided into twelfths and not into tenths for ordinary use. So far as international uses are concerned, the only two measures of much account to engineers and manufacturers generally are the kilogram and the millimetre, and it would not be a matter of two hours' study for every clerk in the country to pick the system up for foreign dealings. What surprises us is the fuss made over the whole matter. In the writer's own dealings abroad, he has simply sent plans to the millimetre scale, and expressed weights in kilograms. There is no difficulty in the mere numbers and standards. But what of screw threads, for example? Are our various threads to be changed? Would the continuation of standard Whitworth threads be permissible, or should the change of system coincide with an international adoption of a standard thread and belt diameter. If we had our way we would treat it as a matter of false measures should a tube manufacturer fail to make all his threads to standard. No one knows how great is the inconvenience caused by the present habits of tube makers whose pipes are not interchangeable. We could not be worse off than we are now, even if the metre were adopted, so long as there could be an agreement all round as to the sizes of tubes to be made standard. We say tubes, to fix one's ideas; but the argument applies all round to thousands of manufactured articles. The change to the metrical system would be no light undertaking. *Electricity*, which appears only able to look at the clerical element, seems to have given no thought to screw threads, rolling mills, and thousands of trade fixtures. For a long time to come the section books of the rolling mills would be crammed with approximate sizes in millimetres—the millimetre being a conveniently small measure for iron rolling purposes; but it is an inconveniently large one for many other things, especially for wires, sheets, &c., which cannot be well expressed in easy decimals of a millimetre. The more one thinks of it, the worse appears the decimal division of standards for convenience of manufacturing. It is not that our present measures are themselves good, but that they are binarily divided, and the metric system is simply a decimally divided system, with very little real connection between its weights and length measures, little better, indeed, than our own 1,000 ounces of water = 1 cubic foot.

Lectures.—We are informed that a course of First Aid Lectures of the St. John Ambulance has been given at the Brook Green Works of the Incandescent Electric Lamp Company, Limited, by Dr. Denne, Sterndale Road, the works' doctor. The whole of 16 men who presented themselves for examination passed. We understand that the information imparted by the Ambulance Society to the pupils is often found very useful at the company's works.

Before the Goldsmiths' Institute Engineering Society to-morrow, Saturday, at 7.30, Mr. G. P. Lewis will read a paper on "Artificial Illumination."

Before the Liverpool Engineering Society on 3rd inst., Mr. Thomas M. Bigley read a paper on "Electric Tramways."

Lord Kelvin read a paper, by himself and Drs. Beattie and Smolan, before the Royal Society of Edinburgh on 1st inst., the subject being "The conductive quality induced in air by Röntgen rays and by violet light."

Electrical Engineer Wanted.—The Ayr Town Council want an electrical engineer to fill the position lately vacated by Mr. Pink. The salary offered is £250 per annum, the engineer engaged to take charge of the whole undertaking, and to have had experience in the high tension alternating system, as in use at Ayr. Applications have to be lodged by 27th inst.

The Death of Galileo Ferraris.—Not all the most affectionate care nor the resources of science could succeed in saving the life of Galileo Ferraris, who died a few days ago surrounded by his friends. Galileo Ferraris was born at Livon on October 3rd, 1847; but his long sojourn, and the love which he has always manifested for Turin, have won for him a citizenship more effectual than that of birth. From various quarters he had been invited to direct scientific institutions, and laboratories, but he always replied that he felt a pride in continuing his career of instruction at Turin, where his mind had been first opened to science. In the field of electricity the name of Galileo Ferraris is among the most distinguished. To his studies and his discoveries in this region is due the world-wide celebrity of his name, reverenced everywhere as that of an acute, profound savant, who has given to electrotechnics one of those laws susceptible of wide practical applications. We need merely refer to his first memoir on telo-dynamic transmission (1868), and to his mathematical theory of the propagation of electricity in homogeneous solids (1872).

Long Burning Arcs.—An American company has been experimenting for some time past with a view to introducing a long burning arc lamp, and has now brought out the "Upton," which is said to be beautiful in appearance, and to give a perfect steadiness of burning and light. It is made in 11 parts, including resistance, inner globe, outer globe, and cover. The upper carbon holder, which is screwed to the end of the cylindrical armature, is a new and novel feature. The carbon is slipped into the clamp, which automatically makes a good contact and positive alignment. The construction of the carbon holder is such as to provide for any expansion or contraction developed in the lamp, and makes it impossible for the carbon to drop out. It is claimed that the lamp is absolutely free from mechanism, has no parts to wear or become gummed, no carbon or guide rods to polish. In placing the resistance under the solenoid, instead of above and close to the ceiling, the fire hazard is reduced to a minimum, and objections of insurance inspectors are overcome. The absence of all clutches, gears, frictions, and other methods for escapement of the carbon ensures an absolutely steady white light. The arc-controlling device maintains a steady voltage at the arc, overcoming the blue-tinted light occasioned by improper escapement mechanism. The method of securing the inner and outer globe renders the lamp entirely free from shadow, and the trimming arrangements of the lamp reduce the labour to a minimum. The lamp was designed by Mr. Henry Hallberg, electrician for the Standard Thermometer and Electric Company, of Peabody, Mass.

Convection Currents.—In the *Zeitschrift für Physikalische Chemie*, 1896, Vol. 20, page 145, Franz Richardz and Carl Lonnes recount their efforts to determine the cause of the currents through acidified water, which occur with electromotive forces insufficient for the decomposition of the water. As hydrogen peroxide is produced with a stronger E.M.F., they considered it probable that a similar formation might also be the cause of the convection currents. Preliminary experiments showed that the peroxide is not produced when the platinum and gold electrodes employed are placed in acidified water, although they contained occluded hydrogen. During the passage of the convection currents, however, hydrogen peroxide is formed, but the quantity produced is insufficient to account for the current, neither is it in any way proportional to the current strength as measured by a silver voltameter. The peroxide is not produced below that of one Daniell's cell. Experiments with solutions of sodium hydroxide showed that sodium peroxide is formed at the cathode, but no barium peroxide is produced in solutions of barium hydroxide.

The Isolation of Lithium and Beryllium.—In effecting the isolation of these metals, W. Borchers treats the minerals with solutions designed to extract the chlorides. These are made slightly alkaline, evaporated in an iron vessel, fused with ammonium chloride and then electrolysed with a current of 1,000 amperes per square meter of cathode surface, and 5 volts. The upper rim of the crucible is kept cool by the circulation of water, and the metallic lithium is prevented from coming into contact with the atmosphere. The same principle is adopted for the isolation of beryllium, *vide Chemiker Centralblatt*, Vol. 2, pages 13 and 14.

Condensation without Water Supply.—The use of condensers is a great economy if the arrangements are good, though we never could see much sense in using, as an air pump, a duplex direct acting steam pump, consuming probably 200 lbs. of water per horse-power-hour. As regards the use of condensing engines without water supply, Mr. Alberger supplies some information in an article in *Cassier's*, the argument being that as the condensing water is cooled by radiation, by absorption of heat by the cooling air, and by the latent heat of vaporisation, the amount of available water is continually growing, the loss of cooling being less than the addition of the condensed steam. Hence it follows that, given enough feed for a non-condensing engine, there will always be more than enough for a condensing engine, which will be from 20 to 30 per cent. more economical to begin with, and the evaporation at the cooler will be less than even the steam used by the condensing engines. It is shown that by means of cooling apparatus, a steam plant need not of necessity be placed near a river or a canal, so long as enough water for boiler feed can be had elsewhere. The author even considers that the newer method has special advantages. Thus the cooler can always be so placed that the water, when cooled, will run to the condenser. This being so, the nuisance of losing a vacuum, so common when a slight drop of vacuum renders the water from a much lower source incapable of flowing up to the condenser, need not occur, and a vacuum may fall to quite a low point and still not fail from absolute lack of water. This is an important point for engines liable to sudden large increases of duty. The particular type of cooler advocated by the author is that of the hollow cylindrical tower filled with numerous layers of drain tiles stood on end, but breaking joint at each layer, so as to form no continuous lines of tube. This tower has an upflowing current of air blown through it by a fan. This does not take more than 2 per cent. of the main engine power to drive it, and an apparatus large enough for 1,000 horse-power is only 15 feet diameter and 30 feet high, and contains simply the 2,000 gallons of circulating water sufficient to fill its pipes, pump, and main, the constant shower on the tiles and a supply in the pit below, whence the injection is drawn to the condenser. The apparatus need not necessarily be near the engine. The exhaust from the auxiliary engines where such are employed is turned into the feed water to the boiler already taken from the hot well, and by this means the auxiliary engines use only the exact heat equivalent of the work they do, otherwise it would be very poor practice to use a direct steam pump as an air pump. That such apparatus could be used in many places where now there is only high pressure working, is very certain. The marvel is that they are not more employed. It is not as though they were expensive.

Preventing Scale in Steam Boilers.—We are frequently seeing references to the use of kerosene as a scale preventive, but we cannot hear much from steam users themselves as to the benefits derivable from kerosene. The *Engineering and Mining Journal* illustrates an oil injector for the purpose of injecting kerosene oil drop by drop into boilers as a scale preventive. We may suppose that the action of kerosene is to prevent the adhesion of scale. The journal rightly says that sulphate of lime scale is even less desirable than the carbonate scale, because when sulphate scale is chipped off, iron rust will be found beneath. This is a fact that we have not previously seen recorded. We noticed the fact—for it is a fact—first in certain boilers at Burton-on-Trent, which were fed with a water containing lime sulphate in large quantity, that plates oxidised beneath sulphate scale. This sulphate derived from the gypsum in the keuper marl of the locality would render the inside of a boiler of a dazzling white all below water line; but under the scale was the gritty black oxide produced by severe corrosion, which seems to be due to the decomposition of the sulphate by heat of the plates and the setting free of the acid. The use of soda in the water is futile, because the soda cannot act below the scale. Anything like kerosene, if it will prevent adhesion, ought to be very valuable, though we should prefer a method which removed the salts before they were placed in the boiler. Not only is the high temperature of boiler plates, when scaled over, conducive to oxidation, but the plates themselves are injured in texture and reduced to a very weak condition.

Comparative Cost of English and American Boilers.—Writing to *Engineering News*, Mr. G. L. Rockwood, M.Am.Soc.C.E., compares the cost of English and American boilers. He takes that very common American boiler, the horizontal return tube, under-fired, flat-ended cylinder. One such, 72 inches diameter and 20 feet long, has about 2,000 feet of heating surface, or 166 H.P. at 12 feet per H.P. It will cost f.o.b. cars $1,000 (about £200), or $6.25 per H.P. These boilers are made of ½-inch plate, triple riveted, with butt strips and holes drilled, and work at 150 lbs., which we would remark is much above the limit allowed on similar work in England. Now a Lancashire boiler, 30 feet × 8 feet, was quoted by Mr. Rockwood at £456, or $2,235. It would have 1,080 feet of heating surface, and would thus cost 207 cents per square foot, as against 52 cents for the American boiler. Mr. Rockwood admits the superiority of the Lancashire boiler, and allows it 230 H.P. at an evaporation of 8,000 lbs. per hour, so that its horse-power cost is only $9.75, after all still higher than the American boiler. So much for his argument. Now for facts. We have before us as we write, estimates and full specifications for a Lancashire boiler 8 feet × 28 feet, suitable for 100 lbs. pressure. Such a boiler would be allowed 150 lbs. in America. Its quoted price, not simply free on rails but delivered on seating, varies from £280 to £340, the latter being by a first class maker second to none. This is only $1,660, and Mr. Rockwood's figures are overstated, and it may be worked out that perhaps such difference as there is, is more than compensated by the superior efficiency of internally fired boilers. Mr. Rockwood points out that the English practice is to use economisers which do not cost above 73 cents per square foot, so that the real cost is reduced. In America economisers cost more than boilers. England, too, has the advantage of cheaper brickwork. Though we do not think any advantage would follow upon the use of the cheap American boilers for permanent work, yet the American boiler is worth more attention than has been accorded it, for when made without a dome it is very easily portable, and is certainly cheap to make, for it is simply a shell, two ends and some expanded tubes, with a few stays and gussets. It ought to be suitable for burning coke, and even with coal it has a good space for a combustion chamber before the gases enter the tubes. Often it is only 12 feet in length, and the stresses which come upon long under-fired boilers are very much mitigated with these short boilers that can hardly strain, however badly supported. In all such comparisons, however, it must be borne in mind that American law allows pressures very greatly in excess of anything we allow here. There is no reason for this in the quality of the plates or workmanship—indeed, the contrary is the case, and nowhere is boiler making advanced to the same pitch of perfection as in England. Yet condemned boilers here could go to America, and be passed for pressures higher than they were allowed new in England. At least they could be as safely allowed it as other boilers on that side. We believe the American boiler insurance people recognise the too high practice and would check it if they could.

The Water Tube Boiler.—Commenting on the trials of the British cruiser *Powerful*, the *Scientific American* emphasises the fact that though light in weight, the coal consumed by the water tube boiler is much more than that used by the Scotch boiler, and instances a case in point of a tramp steamer using only 1·4 lb. Let us suppose a water tube boiler to use 1·7 lb., as did the *Terrible*, as against a possible 1·5 lb., the extra 0·2 lb. for 18,000 H.P. will thus come to nearly 40 tons per day. At a speed of 20 knots, the run to Australia might take 25 days, and the coal would be thus increased 1,000 tons. But with her 3,000 tons of coal capacity, the *Terrible* or the *Powerful* can only run nine days at this speed, and therefore would spend only 360 tons of coal more than with Scotch boilers. If, therefore, the water tube boilers do really save 400 tons of weight of machinery, the ship will be 40 tons of coal in hand after nine days' steaming, as compared with heavier and economical boilers, and less coal to begin with. We don't want economy in a war cruiser. War is expensive enough not to be spoiled by the traditional ha'porth o' tar, and if the water tube boiler will stand, and will not go to pieces of a sudden, as one did so recently in the Frency Navy, then let us have it if it will keep us safe.

Obituary.—We regret to hear of the death of Mr. John Faulkner, of Manchester, who passed away on 7th inst. in his 74th year. His connection with electrical science dates back over 60 years. He was one of the first to introduce a perfect system of lightning conductors. His "electric kite" was applied in early days to high steeples and tall chimneys. One of his earliest applications of electricity was made in connection with signals and bells for coal mines. In 1875 he invented improved electric magnetic telegraph sounders and bells. One of these sounders was adopted by Prof. Bell in his earliest telephonic experiments, and was first exhibited at the Centennial Exhibition at Philadelphia in 1876.

Institution of Electrical Engineers.—The next students' meeting will be held on Wednesday, February 17th, when a paper will be read by Mr. Gustave J. Lemmens, on "The Evolution of the Incandescent Lamp."

Marriage.—Mr. Bernard P. Scattergood, M.A., of Leeds, was, on the 3rd inst., married to Miss Edith Mary Ingham, also of Leeds. Our readers will remember several articles which recently appeared in the Electrical Review, from the pen of Mr. Scattergood. Mr. Scattergood has our best wishes.

Imperial Institute.—Among the lectures announced for delivery before the Imperial Institute, is one by Prof. W. E. Ayrton, F.R.S., on Monday next, at 8.30 o'clock, the subject being "Sixty Years of Submarine Telegraphy." The chairman will be Mr. W. H. Preece, C.B., F.R.S.

The Institution of Junior Engineers.—On Tuesday, February 16th, at 8 p.m., at the Westminster Palace Hotel, Lecture II. on "Dynamo Design, Construction, and Working," will be delivered by Mr. F. A. Nixon.

Open v. Enclosed Arcs.—Whenever an attempt is made, says the New York *Electrical Engineer*, to express the value of the illuminating power of a source of light by designating its candle-power, the result is never a true value of the power of the light. This is because the measurement of candle-power may be the same for lights of widely different qualities. The eye is a much better instrument than the photometer for arriving at an approximate value of the true illumination, because the eye takes quality of light into account as well as mere candle-power. But even the eye is sometimes deceived. As an instance of such deception the following test is interesting. An enclosed arc lamp and an open lamp were placed side by side for comparative test in a large commission house in New York. The test was made in the afternoon, before the sun had gotten well on the horizon; a number of the members of the concern acted as judges of the lights, and decided almost unanimously in favour of the open arc. When darkness set in another test was made, and the same judges, without exception, unhesitatingly gave the preference to the enclosed arc. Whereas, in the daytime the enclosed arc appeared dimmer than the open arc, after dark the reverse was the case. At first sight this seems paradoxical, but the explanation is quite simple. The quality of light rays emanating from the "Pioneer" lamp, which is the enclosed arc above referred to, approaches so closely that of daylight that during the daytime the light of this lamp appears dim compared with the light of an open lamp, whose quality is radically different than that of the sunlight; and, by virtually taking the place of daylight, the enclosed arc is actually much brighter than the other lamp, and appears so to the eye. Compared with the "Pioneer" enclosed arc under these conditions the open lamp looks yellow and dim. The only time to get a practical measure of the value of the light is when darkness sets in. That is when the light is used, and that is when it should be measured. The second test alluded to above was naturally the one to which most importance was attached, and resulted in a signal victory for the "Pioneer" enclosed arc. It is safe to say that in the majority of cases, especially where proper quality of light is necessary, this lamp affords an almost perfect substitute for daylight.

The Bowen Dynagraph Car.—The *Railroad Gazette* describes the above car as being constructed originally to give a record of the actual money cost that was being caused by bad track, but which has been actually made to record the condition of a track, and from this the cost of putting the same in order can be deduced. The car weighs 3,865 lbs., and is simply drawn over the track attached to some other ordinary car. The records by the car show high joints, low joints, gauge, variation, draw-bar pull, and variations of track level. The records are made on paper 18 inches wide, unwound from a drum at a speed of 1 foot per 1,000 feet passed over. The car carries a spring upon which the draw bar pulls. The transverse difference of level of rails is effected by a couple of plungers in cups of mercury, the plungers carrying a recording arm; a pair of wheels carrying no load is placed between the two carrying axles. These wheels simply run on the rail. They record high or low joints, and can move apart or approach each other as the gauge varies. Obviously the passage of a low or high joint will record three marks, one for each wheel, the middle one of double the size of the two outer ones. Clearly there can be no springs to the bearing axles of a dynagraph car, which must pound along, like a military wagon, as best it may. When the paper band is unrolled, it is at once a scale drawing of the track, on which is recorded every imperfection, and these can be sought out and remedied. By suitable calculation from the records, the value of the excess horse-power can be known, and apart from wear and tear of cars, the amount can be calculated that it will pay to spend on the track to remove the imperfections.

Automatic Wire Connector.—Our American contemporaries describe a new automatic wire connector that has some original features worthy of mention. Inside of the shell is slipped a toothed spring, and when the connector is shoved over the wire the teeth prevent its withdrawal. If the connector is to be taken off, a small pin is inserted in the hole, back of the spring, which releases the spring, and the wire is withdrawn. The connections can be instantly

made without the aid of a tool, and it can be taken down without injury to the wire or coupler. The Bradford Belting Company, of Cincinnati, is introducing the connector, which especially recommends itself for emergency work. The absence of solder, the good contact afforded, and the unquestioned strength of the device, will at once suggest themselves as qualities particularly desirable. The spring can be removed, if desirable, but cannot fall out.

Electric Lighting in London.—Writing to the *Daily Telegraph* under date February 8th, Mr. E. J. Kibblewhite, director of the Strand Newspaper Company, says:—

It is a disgrace to the local authorities charged with the administration of the long line of thoroughfare embracing the Strand and Fleet Street, that we should be asked to pay a private monopoly, 6d. per unit, when Brighton gets its electric light for 2½d.

Not only is the Charing Cross and Strand Electricity Supply Corporation demanding more than twice the price that Brighton pays, but it saddles acceptance with a two years' agreement, and its general conditions are irritatingly onerous.

Nor is this all. If the local authorities served us, we should not have our roadways broken up, communication with our premises interrupted, gas and water communications broken, and the general annoyance and loss inflicted on us which we have endured here in the Strand since August last. I speak from unpleasant personal experience, and I know that scores of other Strand ratepayers have read your leader to-day with lively interest.

Secret Commissions.—The question of secret commissions in trade has recently occupied the attention of the London Chamber of Commerce, and has led that body to appoint a special committee to inquire into and report upon the subject of the "pernicious practice of giving and receiving secret trade commissions." The secretary of the Chamber writes to the Press, stating that the committee are willing to receive and consider confidentially any evidence or information on the subject which any one may be disposed to bring before it.

Short-Stroke Engines.—In connection with our article on this subject in another column, we reproduce the following letter which appeared in last week's *Engineering*, from Messrs. Browett, Lindley & Co., Limited:—

As sole makers of the Westinghouse engine in this country in its double-acting form, we wish to point to what is probably a clerical error in Mr. Raworth's interesting paper on "Short-Stroke Steam Engines," published in your last issue, and we refer to the amount of loss through port friction as given for this engine in comparison with his own and another. The amount is obviously incorrect, and we see no reason why it should be more than in the "Universal" engine, beyond the fact that for constructional reasons it may pay to sacrifice a little in this direction in order to obtain a smaller and, therefore, lighter valve. Before a comparison of this kind can be satisfactorily made, some particulars as to speed, &c., ought to be furnished.

We notice that he publishes a table of steam consumptions of the Westinghouse engine only, and though the results are, we should think, enough to satisfy most people, they should be supplemented with information as to the condition of the trial before they can be of much value.

We hope to be able ourselves, before very long, to give such information on engines made by ourselves, and to show, if possible, even a higher economy than that given in the table.

Electric Light in Capillary Tubes.—Schott (*Wied. Ann.*, 59, p. 768), describes some interesting phenomena which he has observed on sending the spark of an induction coil through a very narrow capillary glass tube. A capillary tube, 60 mm. in length and 0·05 to 0·08 mm. internal diameter, is joined on at each end to prolongation tubes of several millimetres diameter, and 100 to 120 mm. in length, which latter tubes are intended to receive aluminium electrodes by means of which the spark is sent through the air in the capillary tube. The air in the capillary tube was at atmospheric pressure, and when a 25 cm. (9·8 inches) spark coil, excited by eight accumulators, was connected to the aluminium electrodes, an exceedingly bright light was emitted from the capillary tube. When the experiment was continued for some time, the capillary tube became hot and conducting, and the light died out; but if the tube was surrounded by a water jacket, the light remained undiminished for half an hour or longer. If after such an experiment the tube was examined with a magnifying glass, its walls appeared dull and rough, like finely-ground glass, and spherical expansions at regular distances, but of irregular size, could be seen along the tube. When the picture of the luminous tube was projected on a screen, the luminous line was seen to be interrupted by dark spots corresponding to the expansions in the section of the tube. Wider tubes of 0·2 mm. diameter gave a less intense light of reddish-violet colour; and narrower tubes of 0·02 to 0·03 mm. gave a more intense light, but became sooner dull. Photometric determinations with these latter tubes showed that the light at first was about 2 candle-power, but soon fell off to 1·5 candle. Schott estimated that if the discharge in the tube was continuous, the intensity of the light would be from 1,000 to 2,000 candles. He estimated, also, that the emission per unit of radiating surface would far exceed that of the arc light. This light, owing to the simplicity of its production and its extraordinarily high intensity, appears to be worth further investigation.

Correction in Mr. Andrews's Paper.—In the last par of the paper on switch gear, "shunt of 32 volts" should read "shunt of 22 volts."

NEW COMPANY REGISTERED.

Jandus Arc Lamp and Electric Company, Limited (Continental Patents), (51,092).—Registered February 2nd, with capital of £100,000 in £1 shares, to enter into an agreement with J. B. Barton, W. Jandus, and W. C. Johnson, and to manufacture, sell, supply, and deal in Jandus electric arc lamps and other electric lamps and apparatus. The subscribers (with one share each) are:—E. N. Galloway, Normanby, Altrincham, engineer; T. A. Earle, 88, King Street, Manchester, agent; J. T. Petrocockino, 6, Mensball Street, Manchester, merchant; A. A. Gillies, 46, Brown Street, Manchester, chartered accountant; B. M. Drake, 66, Victoria Street, S.W., electrical engineer; J. M. Gorham, 66, Victoria Street, S.W., electrical engineer; S. Paterson, 16, Doughty Street, W.C., electrical engineer. The number of directors is not to be less than three nor more than seven; the first are B. M. Drake, W. C. Johnson, A. Earle, S. Paterson, E. N. Galloway, J. T. Petrocockino, and J. B. Barton; qualification, 200 shares; remuneration as the company may decide. Registered by C. Doubble, 14, Sergeant's Inn, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Chelmsford Electric Lighting Company, Limited (36,124).—This company's annual return was filed on December 19th. The capital is £10,000 in £1 shares (of which 7,500 are preference). All the preference and 2,378 ordinary have been taken up, and the full amount called. £9,871 has been paid, leaving £7 unpaid.

Chloride Electrical Storage Syndicate, Limited (35,389).—This company's annual return has just been filed. The capital is £262,500, in 80,000 "A," 30,000 "B," 140,000 "C," and 12,500 founders' shares of £1 each. The "A," "B," and founders' shares have been taken up, and 100,000 of the "C" likewise, and 157,500 are considered as paid. The full amount has been called on the others, and £65,000 has been paid.

Wimshurst, Hollick and Company, Limited (41,466).—This company's annual return was filed on November 28th. The capital is £40,000, in £5 shares, of which 4,000 are preference. 4,000 ordinary and 895 preference have been taken up, and the ordinary are considered as paid. The full amount has been called on the preference, and £4,475 has been paid.

R. Waygood & Co., Limited (42,679).—This company's annual return was filed on January 13th. The capital is £60,000, in £10 shares (of which 3,000 are preference). 2,500 ordinary and 2,500 preference have been taken up, and all the ordinary and 1,500 preference are considered as paid. £10 per share has been called and paid on 1,000 preference.

Simplex Electric Tramway Conduit Syndicate, Limited (48,119).—This company's statutory return was filed on October 9th. The capital is £30,000, in 5,000 "A" and 25,000 "B" shares of £1 each; 3,000 "A" have been taken up, and 15s. per share has been called, £750 has been paid, and £1,500 is in arrears.

CITY NOTES.

St. James's and Pall Mall Company. Analysis of Production.

It is a little remarkable that the success of this company should have been most marked since it came outside its close district and entered into competition. We do not advance that as a reason for its conspicuous success; but it certainly shows that the alarm with which the company some time ago viewed the reduction of price by competitors was unnecessary. The chief features of the 12 months' working were shown in our report last week of the company's meeting.

The following table gives the cost per unit:—

	1896.	1895.
Total capital invested	£250,000	£250,000
Number of units sold	2,401,431	1,846,064
Number of lamps connected	108,803	—
Revenue from sale of current	£53,967	40,670
Net revenue	£25,339	14,580
Average price obtained per unit	5·39d.	5·29d.

Cost of production.	£		Per unit.	1895.
Coal	5,024		·50d.	·59.
Oil, waste, water and engine room stores	818		·08d.	·09d.
Salaries and wages at generating station	4,705		·47d.	·59d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	2,886	Works' cost 1·54d.	·29d.	·40d.
Rates and taxes	2,239		·22d.	·27d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges, and insurance	6,701		·67d.	·84d.
Depreciation of buildings and plant account	—		—	—
Renewal fund account	—		—	—
Total	£22,373		2·23d.	2·78d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	53,967	0	0	5·39d.
Meter rents	1,274	0	0	—
Sale of lamps	—			—
Total	£55,241	0	0	5·39d.

Total cost per unit (exclusive of depreciation and renewal accounts), 2·23d.; works' cost, 1·54d.

National Electric Supply Company.

The accounts of this company show a very satisfactory record, as far as increased business is concerned; but in cost of production, the results achieved by Mr. Tonge, the engineer to the Preston Company, are exceedingly noteworthy, and are indeed not far removed from the record costs which have been not unduly lauded of late. It is interesting to hear what the directors have to say, and their remarks are as follows:—

The expenditure on capital account now stands at £70,680, a sum of £3,640 having been added during the year. The mains have been extended in Bow Lane, Ribblesdale Place, Upper Walker Street, Meadow Street, Glover Street, and Garstang Road. A new feeder main has also been laid from the works, to meet the increasing demand in Winckley Square and the neighbourhood. Thirty new arc lamps for public street lighting have been erected, and the necessary connections made to the mains. The required capital has been raised by the issue of second debentures, at 4½ per cent. per annum. The gross profit for the year is £4,025 7s. 5d., an increase of £1,623 14s. 4d. over last year. After paying debenture and bank interest, the directors recommend that the balance should be appropriated as follows:—

	£	s.	d.
To Interest on debentures and bank interest	1,115	17	0
„ Depreciation on machinery, &c., and to provide for bad and doubtful debts	409	13	11
„ Writing off loss on working during 1892 and 1893	1,000	0	0
„ Reduction of preliminary expenses	174	17	11
„ Payment of a dividend, at the rate of 2½ per cent. per annum on the ordinary shares of the company, for the year ending December 31st, 1896	1,324	18	7
	£4,025	7	5

The cost of production is as follows, but we have left out of the debit side the cost of attending public lamps, private lamps and motors, and the figure relating to the expense of raising capital.

The following table gives the cost per unit:—

	1896.	1895.
Total capital invested	£78,735	£73,235
Number of units sold	320,500	271,076
Number of lamps connected	—	—
Revenue from sale of current	£6,514	£5,509
Net revenue	£4,025	£2,401
Average price obtained per unit	5 08d.	4 88d.

Cost of Production.	£		Per unit.	1895.
Coal	509		·38d.	·44d.
Oil, waste, water, and engine room stores	134		·10d.	·19d.
Salaries and wages at generating station	723		·54d.	·65d.
Repairs and maintenance of buildings, engines, boilers, dynamos, &c.	256	Works' cost 1·25d.	·19d.	·35d.
Rates and taxes	296		·22d.	·29d.
Management expenses, directors' remuneration, salaries of managing engineer, secretary, clerks, &c., stationery and printing, general establishment charges, auditors, law charges and insurance	653		·49d.	1·03d.
Depreciation of buildings and plant account	—		—	—
Renewal fund account	—		—	—
Total	£2,571		1·92d.	2 95d.

Revenue.	£	s.	d.	Average price obtained per unit.
By sale of current	6,514	0	0	5·08d.
Meter rents, &c.	208	0	0	—
Sale of lamps	—			—
Total	£6,722	0	0	5·08d.

Total cost per unit (exclusive of depreciation and renewal accounts), 1·99d.; works' cost, 1·25d.

The National Telephone Company, Limited.

The report of the directors for the half-year ending December 31st, 1896, to be presented to the shareholders at the nineteenth ordinary general meeting of the Company, to be held at the City Terminus Hotel, Cannon Street, London, on Thursday, February 18th, 1897, at 1 o'clock p.m., states that the income accrued in respect of the business of the half-year amounts to £439,978 2s. 4d., as compared with £422,649 6s. 9d. for the corresponding period of 1895, being an

increase of £17,328 15s. 7d. The working expenses for the half-year amount to £245,278 13s. 9d., as compared with £216,537 0s. 5d. for the corresponding period of 1895, being an increase of £28,741 13s. 4d. The net result for the half-year (after deducting the Post Office royalties amounting to £39,717 0s. 3d.) is a profit balance of £154,982 8s. 4d., as compared with £167,873 14s. 3d. for the corresponding period of 1895, being a decrease of £12,891 5s. 11d., a consequence of the loss to the company of the revenue derived from trunk lines transferred to the State as explained. The rentals carried forward for unexpired terms of running contracts amount to £414,714 9s. 8d., as compared with £354,635 12s. 1d. at the corresponding period of 1895, or an increase of £60,078 17s. 7d. Out of the available balance of £137,306 16s. 9d., shown by the net revenue account, the board will recommend the payment of a dividend at the rate of 6 per cent. per annum, less income-tax, on the first and second preference shares, 5 per cent. per annum, less income-tax, on the third preference shares, and 6 per cent. per annum, free of income-tax, on the ordinary shares. The board also propose to transfer £35,000 to the reserve fund, and to carry forward the balance of £5,713 0s. 9d. *Capital Expenditure.*—As will be seen by reference to capital account, the sum of £233,112 4s. 10d. has been expended on the construction of exchange and private lines during the half-year. As was the case in the previous half-year, a not inconsiderable proportion of this outlay is attributable to the substitution of metallic circuits for single lines, and the construction of underground work in lieu of overhead wires, for the purpose of securing greater efficiency of service to subscribers in the more important and crowded centres, more particularly in relation to the trunk line service of the State. Previously to the commencement of the half-year, the whole system of the company's trunk lines had been transferred to the State, which has involved a diminution of gross revenue for the six months of about £40,000. Against this may be placed the reduced cost to the company of the wayleaves, the repairs and maintenance of the trunk lines themselves, and the Post Office royalty on that revenue, besides which the company are gainers by the interest accruing upon the purchase money. A further compensating advantage may be found in the more rapid development of the exchange business to be anticipated from the considerable extension of the trunk system erected, and in process of erection, by the Post Office. Naturally, the change of system involved in a dual control has led to some temporary inconvenience, of which the public may reasonably complain, but this was inevitable under the circumstances. The company are loyally co-operating with the Post Office, in view of, as speedily as possible, bringing the trunk line service of the country to the highest state of efficiency.

Anglo-American Telegraph Company, Limited.

The meeting of this Company was held last Friday, at Winchester House. The following report was presented by the directors:—

"The total receipts from July 1st to December 31st, 1896, including the balance of £1,803 5s. 3d. brought forward from the last account, amounted to £171,869 12s. 5d. The traffic receipts show an increase of £10,823, as compared with the corresponding period of last year. The total expenses of the half-year, including the repair of cables, &c., as shown by the revenue account, amounted to £58,000 7s. 9d., being an increase of £3,204 17s. 8d. The directors, under the powers conferred upon them by the articles of association, have, before declaring the net profits, set apart the sum of £12,000 to the renewal fund, leaving a balance of £101,869 4s. 8d. Interim quarterly dividends of 12s. per cent. on the ordinary stock, and £1 4s. per cent. on the preferred stock, were paid on November 1st last, absorbing £42,000, leaving a balance of £59,869 4s. 8d, out of which the directors recommend the proprietors to declare final dividends of 17s. per cent. on the ordinary stock, and £1 14s. per cent. on the preferred stock, amounting to £59,500, making a total distribution for the year ending December 31st, 1896, of £2 13s. per cent. on the ordinary stock, and £5 6s. per cent on the preferred stock, leaving £366 4s. 8d. to be carried forward to the next account. The company's s.s. *Minia* has been employed during the past half-year in the repair of several of the short cables of the company on this and the other side of the Atlantic, and of the 1880 main cable. The 1880 cable has again been broken in shallow water near Newfoundland, and will be repaired in the spring. The other cables and the land lines of the company are in good working order. The directors greatly regret to announce the resignation of their esteemed colleagues, the Marquis of Tweeddale and Sir Albert J. Leppoc Cappel. The vacancies thus created on the direction have been filled by the appointment of Sir Gerald FitzGerald, K.C.M.G., and Mr. Robert H. Benson. The board unanimously elected Mr. Francis A. Bevan as chairman. An influentially-signed petition has been presented to the directors asking for the appointment of Mr. Herbert Samuel Leon to a seat on the Board. Mr. Leon holds a large amount of the company's stock, and has a considerable telegraphic correspondence with America, and the directors recommend his election by the meeting.

The ordinary general meeting of the shareholders was held on Friday last at Winchester House. Mr. F. A. Bevan presided, and expressed the regret felt by the board at the retirement of the Marquis of Tweeddale from the chairmanship of the company. To fill the vacancies on the board caused by the retirement of the Marquis of Tweeddale and Sir Albert Cappel, the directors had elected Sir Gerald Fitzgerald and Mr. R. H. Benson, and they had also agreed to recommend the election as a director of Mr. H. S. Leon, one of the company's best customers, in response to an influentially signed petition to that effect. Turning to the business of the company during the half-year ended December 31st last, he stated that steady progress had been made, and the board were enabled to pay £2 13s. per cent. on the ordinary stock for the whole year, as compared with £2 9s. in the previous 12 months. The report alluded to the breaking of the 1880 cable, but it was not a really serious matter. It had been broken in shallow water, and there could not be the slightest doubt that so soon as fine weather returned they would be able to repair it. The importance of their having three cables in working order was great, as otherwise their proportion of receipts from the pool would not be kept up to its present figure. It was owing to the breaking of their cables from time to time that the board held very strong opinions as to the necessity of the company possessing a large renewal fund. The 1869 cable had been down about 24 years, and two of their existing cables dated back to 1873 and 1874 respectively. These two cables had, therefore, been down nearly as long as the 1869 cable. He did not say that the 1873 and 1874 cables, which were of the same type as the 1869 cable, were going to fail, but he contended that, in view of all the facts, it would be very foolish if they neglected to strengthen the renewal fund. The amount now standing to the credit of that fund was only a little more than sufficient to provide a new cable. He hoped, therefore, that the action of the board in adding to it annually £24,000 out of the profits of the company would be approved by the shareholders. Having stated that the board proposed that the company should subscribe 100 guineas to the Sir John Pender memorial fund, he concluded by moving the adoption of the report.

Mr. Charles Bubt seconded the motion, and after a short discussion, the report was adopted.

The Cuba Submarine Telegraph Company, Limited.

The report of the directors for the half-year ending December 31st, 1896, to be presented at the fifty-first ordinary general meeting of shareholders, to be held on February 17th, 1897, states that the directors beg to submit, duly audited, the balance-sheet and accounts for the half-year ended December 31st last. From these it will be seen that the gross receipts amount to £28,681 3s. 9d., and the gross expenditure to £8,352 5s. 3d., leaving a sum of £20,328 18s. 6d., which, added to the balance of £3,170 11s., brought from the last account, leaves £23,499 9s. 6d. at the credit of revenue account. The increase in the stations' expenses over those for the corresponding period of 1895 has arisen from the working of the stations of the Cienfuegos-Manzanillo cables, which, as mentioned in last report, were opened on Jaunary 1st, 1896. The sum of £11,000 has been added to the reserve fund, which now stands at £109,000. The dividend on the preference shares will absorb £3,000, and leave £9,499 9s. 6d., out of which the directors recommend the payment of a dividend on the ordinary shares at the rate of 8 per cent. per annum, free of income-tax, the balance, £3,099 9s. 6d., being carried forward to the current half-year. The cables have continued in good order throughout the half-year, with the exception of the Cienfuegos-Santiago 1881 cable, which broke down in December, and arrangements are now being made for its repair. The directors regret to report that a cable has been laid between New York and Hayti, in connection with the French Company's system, and which has deviated that company's traffic from the Cuba Company's lines. A special meeting has been convened to make an addition to the articles of association, which is deemed advisable in the interests of the company.

Westminster Electric Supply Corporation, Limited.

The report of the directors states that the business of the corporation continues to make satisfactory progress. The supply of current which, on December 31st, 1895, was provided for the equivalent of 210,982 lamps of 8 C.P., had increased by December 31st, 1896, to the equivalent of 249,318, and at the present time there are on circuit the equivalent of 253,383 lamps of 8 C.P., and applications have been received for a further 4,624. The length of roadway in which mains have been laid now exceeds 41 miles, making about 170 miles of ways, into which upwards of 141 miles of copper (strip and cable) have been drawn. The plant and machinery have been working satisfactorily throughout the year, and have been fully maintained from revenue, and a further reduction has been effected in the cost per unit, in generating, distributing, and general expenses. In consequence of the increase in the business of the corporation, the directors have made a contract for the extension of the central station in Millbank Street, upon the additional ground acquired as reported at the last general meeting. The board are glad to report that they have also been able to arrange for additional land at Davies Street, on which to provide further boiler power, rendered necessary by the greatly increased load at Davies Street station. In dealing with the revenue of the past year, the directors have, after writing off bad debts, the balance of preliminary expenses, and placing £1,000 to credit of sinking fund, added a sum of £12,100 to the depreciation account. The net revenue of the year amounts to £33,973 6s. 7d. As stated in the last annual report, after payment of 7 per cent. the holders of the founders' shares, become entitled to a share of the profits. The net revenue after payment of the 7 per cent. shows a balance of £10,208 6s. 7d., of which one quarter, or £2,552 1s. 8d. is due to the founders' shareholders, which, added to the sum of £334 14s. 9d. brought forward from last year, makes a sum of £2,886 16s. 5d. due to the founders, or £28 17s. 4d. per share, less income tax. An interim dividend, at the rate of 6 per cent. per annum, for the half-year ending June 30th, 1896, has been distributed. The balance to the credit of the ordinary shareholders, including the sum of £1,004 4s. 5d. brought forward from last year, is sufficient for payment of a dividend of 9 per cent. for the past year. The board therefore recommend the pay-

ment of a dividend at the rate of 12 per cent. per annum, less income tax, for the past half-year, making 9 per cent. for the year ending December 31st last, carrying forward a balance of £1,646. The directors have for some time had under consideration the question of the advisability of redeeming the founders' shares, and recently came to the conclusion that it was greatly to the interest of the ordinary shareholders to endeavour, without further delay, to come to terms. They therefore approached the founders' shareholders, who have held a meeting, and stated to the board that they are willing to accept 80 ordinary shares of £5 each, fully paid, in exchange for each founders' share of £5. The board, at their meeting on January 20th, decided to recommend the shareholders to accept this offer, and an extraordinary meeting will be held to consider the matter in accordance with the notice sent herewith. In accordance with the articles of association, two of the directors, W. Hayes Fisher, Esq., M.P., and R. W. Wallace, Esq., Q.C., retire, but, being eligible, offer themselves for re-election.

Liverpool Overhead Railway Company, Limited.

The half-yearly general meeting of the shareholders of the Liverpool Overhead Railway Company was held on Tuesday, at the Law Association Rooms, Cook Street, Liverpool. Mr. Richard Hobson presided, in the absence of the chairman, Sir Wm. Forwood, and there was a large attendance. The directors' report and statement of accounts showed the gross revenue to amount to £32,783, and working expenses to £20,954. The number of passengers carried during the six months was 3,919,134, compared with 3,780,375 in the corresponding half-year in 1895, showing a continued and steady increase. The sum available for dividend was £12,177, out of which the directors recommended the payment of dividends at the following rates (less income-tax): 5 per cent. per annum on preference shares, and 3 per cent. per annum on ordinary shares, leaving £3,064 to be carried forward.

Mr. S. B. Cottrell, M.Inst.C.E., engineer and manager, reported that the permanent way, buildings, works, plant, &c., had been maintained in good working order and repair during the half-year.

The Chairman, in moving the adoption of the report, said the number of passengers carried during the past half-year showed, comparatively speaking, only a moderate increase over the corresponding half of 1895, but taking the year altogether, they had carried during 1896, 7,659,000 passengers, which was equivalent pretty nearly to carrying the whole population of Liverpool, men, women, and children, some twelve and a half times within the 12 months. This conclusively proved the value of the railway to the inhabitants and the trade of Liverpool. With regard to the southern extension to the Dingle, which was opened on December 21st last, there had been so much delay and anxiety in connection with it that it had been a positive relief to the directors to get it completed. They had met with one or two difficulties so serious as to cause a delay of months in the opening of the line. The chief of these was the crossing of the Cheshire Lines tunnel. The engineers calculated, as they were fully entitled to do, to find good solid ground in excavating close to the arch of this tunnel, in which case there would have been no difficulty. Instead of that, however, the ground was exceedingly loose, and necessitated a retaining arch being constructed over that of the Cheshire Line's tunnel, and this was a difficult and delicate work, involving serious delay. Another delay arose from the substitution of a long span bridge of 220 feet at the south end in spite of the originally-designed structure of two spans, the alteration being insisted on by the Dock Board at the last moment, in view of possible requirements of the future. The railway was now carried out to the full extent of the Parliamentary powers. The reproach at one time frequently cast against the company, that they started nowhere and ran nowhere, was now removed, and they had now a considerable population at each terminus. The only unfavourable feature in the report was the reduction in dividend. It was not necessary for him to tell them that a work of the extent which the company had had in hand, including a large expenditure of capital and the long time required in construction, could not be undertaken without at some time or another involving a considerable loss of interest, whilst the capital expended was not in a dividend-producing condition. That had been the exact position of the company during the past half-year. Their dividend in June, 1895, was 2½ per cent., and in December, 1895, 3½ per cent., making an average of 2⅞ per cent., which required to pay it £11,069. The dividend in June, 1896, was 2⅝ per cent., and what the directors ask the meeting now to sanction was 3 per cent., making an average for the year of 2⅞ per cent., the same as in 1895; but which required £11,980 to pay it. The accounts showed an expenditure of £539 for repairs and renewals, against £179 in the corresponding period of last year. This was necessary in order to keep the railway and rolling stock in the most efficient condition.

Mr. Edward Lawrence seconded the motion.

Mr. Harvey Woodward urged an improvement in the train service to the north end, to meet the competition of the Lancashire and Yorkshire Railway. He also complained that the electric lighting of the carriages was very bad.

The Chairman, replying to this and other questions by shareholders, said the lighting of the carriages had given a great deal of trouble, but the manager thought they would be able in the end to overcome the difficulty regarding it. Careful consideration will be given to the north end service, and probably they would be able to do away with any cause of complaint there. As far as they could see, the traffic on the south end extension had been satisfactory, the receipts having increased during January about £600 over January, 1896, and a great deal of that was due to the opening of the south branch.

The motion was then carried, and a proposition for the payment of the dividend stated above was also agreed to.

Messrs. James Barrow and Richard Hobson having been re-elected to the board of directors, the business of the general meeting terminated.

An extraordinary meeting was then held for the purpose of considering a resolution authorising the company to raise £65,000 (in addition to £125,000 already borrowed under the Liverpool Overhead Railway Act, 1892) by the creation and issue of debentures.

The Chairman proposed the resolution, observing that the money was required to meet liabilities on account of the southern extension. They proposed to issue 4 per cent. debentures obtainable by tender at a premium. As the company's debentures were quoted in the market at 110 to 112, they would probably be able to command 109 to 110 for this new issue. This would give a little over 3 per cent. to the lender. The debentures would be issued as required.

Mr. Lawrence seconded, and the motion was agreed to.

Official Announcements re Companies.—The *London Gazette* for January 29th contained notification, signed by J. S. Purcell, Register of Joint Stock Companies, to the effect that at the expiration of three months the names of the following companies will, unless cause is shown to the contrary, be struck off the Register, and the companies will be dissolved:—

Blockley Electric Lighting and Manufacturing Company.
Brighton and Hove Electric Light Company.
British Electric Light Company.
Denison Auto-Telegraph Machine Syndicate.
Electric Fittings, Hiring and Maintenance Company.
Electricity Users Association.
Electric Lamp Company.
Electro-Alkali Company.
Electro-Cyanide Gold Recovery Syndicate.
Gordon Electric Traction Syndicate.
Isle of Wight Electric Lighting Company.
Kennedy Storage Battery Company.
Lightning Express Railway Syndicate.
Llanelly Electric Light and Power Company.
Mildé Telephones and Electric Supply Company.
Port Beira Pier Tramway and Telegraph Company.
Sanderson's Patent Feed-water Purifiers and Heaters.
Smokeless Fuel Syndicate
Tramways Automatic Stopping and Starting Gear Company.
Waterhouse Electrical Manufacturing Company.
Waterhouse Electrometric Syndicate.

The Edison and Swan United Electric Light Company, Limited.—The directors recommend that a payment on account of the dividend of the current year be made at the rate of 5 per cent. per annum, less income tax, on the "A" shares of the company, in respect of the half-year ended December 31st, 1896. This will work out at 1s. 6d. per share on the partly paid £5 shares (£3 paid), and 2s. 6d. per share on the fully paid £5 shares, less income tax. The payment will be made upon the register as it stood on the 9th inst., and the dividend warrants will be issued on the 23rd inst.

W. T. Henley's Telegraph Works Company, Limited.—For the year ending December 31st, 1896, the directors recommend a dividend of 7 per cent. on the ordinary shares, making, with the 3 per cent. already paid, 10 per cent. for the year, and on the preference shares 3½ per cent., making 7 per cent. for the year. The amount carried forward to next year is £14,294.

Telegraph Construction and Maintenance Company.—Subject to the audit of the accounts, the directors propose paying a dividend of 10 per cent. (£1 4s. per share), in addition to the 5 per cent. already paid, making 15 per cent. for the year 1896.

Stock Exchange Notices.—The committee has ordered to be quoted in the Official List, Metropolitan Electric Supply Company, Limited, further issue of £70,000 4½ per cent. first mortgage debenture stock.

Liverpool Rubber Company, Limited.—The directors recommend a further dividend of 5 per cent., making, with the interim dividend paid in July, 7½ per cent. for the year 1896, carrying £10,722 17s. 3d. to the new account.

City of London Electric Lighting Company.—The transfer books and register will be closed from 10th to 24th inst. inclusive.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending February 7th, 1897, were £1,123; week ending February 9th, 1896, £972: increase, £151; total receipts for half-year, 1897, £6,611; corresponding period, 1896, £5,997; increase, £614.

The Great Northern Telegraph Company. The receipts in January, 1897, were £21,200; corresponding month, 1896, £22,400; corresponding month, 1895, £23,200.

The Liverpool Overhead Railway Company. The receipts for the week ending February 7th, 1897, amounted to £1,241; corresponding week last year, £1,090; increase, £151.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 5th, 1897, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,375.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, Feb. 3rd.	Closing Quotation, Feb. 10th.	Business done during week ended Feb. 10th, 1897. Highest.	Lowest.
173,400£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	100 —104	100 —104	...	...
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	8½— 9½	8½— 9½	...	...
1,012,880£	Anglo-American Teleg., Ltd.	Stock	£2 2s.	£2 9s.	...	53 — 56	53 — 56	55	53½
2,993,560£	Do. do. 6 % Pref.	Stock	£4 4s.	£4 18s.	...	98 — 99	97 — 98	99	97½
2,993,560£	Do. do. Defd.	Stock	...	...	...	9½ — 10	8¾ — 9¼	9½	9
136,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	...	15¼ — 15⅝	15¼ — 15⅝	15½	15¼
75,000£	Do. do. 5 %, Debs., 2nd series, 1906	100	5 %	5 %	...	113 —117	113 —117	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	2½%	4 %	...	3¼— 3⅜	3¼— 3⅜	...	...
16,000,000$	Commercial Cable Co.	$100	7 %	7 %	...	170 —175	170 —175	170	...
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	1½%	...	1/16— 3/16	1/16— 3/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	...	12 — 13	12 — 13	12⅞	...
5,000	Do. 10 % Pref.	10	10 %	10 %	...	19 — 20	19½— 20½	20	19⅜
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	...	3½— 4½	3½— 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	...	10 — 10½	10 — 10½	...	...
80,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	...	105 —108%	105 —108 %	...	...
50,710	Direct United States Cable, Ltd.	20	2 %	2½%	...	9½— 10	9 — 9½	9⅝	9½
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	...	17½ — 17⅝	17 — 17½	17⅛	17⅛
70,000	Do. 6 % Cum. Pref.	10	6 %	6 %	...	18 — 19	18 — 19	...	...
102,100£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	...	103 —105 xd	103 —105	...	...
1,297,837£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	...	130 —133	130 —135	130½	130
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	...	17½ — 18	17½ — 18	18	17 11/16
54,100£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	...	100 —104	100 —104	...	...
194,300£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	...	101 —104	101 —104	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	...	129 —132 xd	129 —132	...	...
80,600£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	...	100 —104	100 —104	...	...
107,600£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	...	101 —104	101 —104	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	...	107 —110 xd	107 —110	108	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	...	110 —113	109 —112 %	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	...	10⅜— 11⅛	11 — 11⅛	11 7/16	11
180,042	Do. do. 6 % Pref.	10	6 %	6 %	...	17¼ — 17⅜	17¼ — 17⅜	17 9/16	17¼
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	10 %	...	24½ — 25½	24½ — 25½	26	25⅝
180,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	104 —107	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	...	53 — 56	53 — 56	55½	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs.	100	6 %	6 %	...	109 —112	109 —112	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2½	2 — 2½	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5½%	6 %	7⅜— 8	7⅜— 7⅝	7⅜	7⅜
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	17 — 19	17 — 19	18⅜	...
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	17 — 19	17 — 19	18	17
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6⅜— 7	6⅜— 6⅞	6⅜	6 9/16
1,100,000£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	105 —108	105 —108	106¾	105
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	4½%	5 %	...	11/16— 13/16	11/16— 13/16	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	...	106 —109	106 —109	...	...
11,839	Reuter's Ltd.	8	nil	5 %	...	7 — 8	7 — 8	7⅝	...
3,381	Submarine Cables Trust	Cert.	...	...	...	138 —143	138 —143	141½	...
58,000	United River Plate Teleph., Ltd.	5	3 %	4 %	...	3¼— 3⅜	3¼— 3⅜	...	...
146,732£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	100 —105	100 —105	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	nil	4 %	...	5 — 6	5 — 6	...	...
238,380£	Do. do. do. 5 % Debs.	100	5 %	5 %	...	103 —106	103 —106	...	...
30,000	West Coast of America Teleg., Ltd.	10	nil	nil	...	½ — 1	¾ — 1¼	1	...
150,000£	Do. do. do. 8 % Debs., repay. 1902	100	8 %	8 %	...	96 — 102	98 — 104	...	...
64,248	Western and Brazilian Teleg., Ltd.	15	3 %	3 %	...	9 — 9½	8¾ — 9¼	9¼	...
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	...	7 — 7½	6¾ — 7¼	...	...
33,129	Do. do. do. Def. Ord.	7½	1 %	1 %	...	2¾ — 3¼	2¾ — 3¼	3 1/16	2⅞
165,280£	Do. do. do. 6 % Debs. "A," 1880 Red.	100	6 %	6 %	...	110 —114 xd	110 —114	111½	111
206,400£	Do. do. do. do "B," do.	100	6 %	6 %	...	109 —113 xd	109 —113	110	109½
88,321	West India and Panama Teleg., Ltd.	10	½%	⅜%	...	1⅛— 1⅜	1⅛— 1⅜	1 5/16	1¼
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	...	11½ — 12	11½ — 12	11 13/16	11⅝
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	...	9½ — 10½	9½ — 10½	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	...	107 —110	107 —110	...	...
1,777,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	...	107 —112	107 —112	...	...
164,300£	Do. do. 6 % Ster. Bonds. ...	100	6 %	6 %	...	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	5 %	...	9¾— 10¼	10 — 10½	10⅜	...
10,277	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	...	8½— 9	8½— 9	...	...
60,000	Do. do. 4½ % Deb. Stock Red. ...	Stock	...	4½%	...	112 —115 xd	112 —115	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	5 %	...	15½ — 16½	15½ — 16½	16¼	15⅞
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	...	16½ — 17½	16½ — 17½	17¼	16¾
300,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	...	128 —132	129 —133	132	129
22,475	County of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	nil	...	9¼— 9⅝	9½ — 10	9⅝	9½
20,000	Do. do. do. 6% Pref., 40,001—50,000 ...	10	...	6 %	...	13⅝— 14½	14 — 14½	...	...
10,000	Do. do. do. iss. at 2 pm., all paid	10	...	...	...	10 — 10½	10½ — 10⅝	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	3 %	4 %	...	13½ — 14½	13½ — 14½	14½	13 13/16
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem., £1 paid	10	...	...	...	6⅝— 7½	7 — 7½	7¼	7⅛
150,000£	Do. 4½% first mortgage debenture stock	...	4½%	4½%	...	119 —122	119 —122	119	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	1 %	2 %	...	11 — 12	11 — 12	...	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	6½%	7½%	10½%	13 — 14	13 — 14	13⅜	13½
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	9½ — 10½	9½ — 10½	10	9⅜
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	104 —107	104 —107	107	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 60,000 ...	5	5 %	7 %	9 %	11½— 12½	11½— 12½	12¼	11⅞

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless therwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

‡ Dividends marked § are for year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES—*Continued.*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share ‡	Dividends for the last three years.			Closing Quotation Feb. 3rd.	Closing Quotation. Feb. 10th.	Business done during week ended Feb. 10th, 1897	
			1894.	1895.	1896			Highest.	Lowest.
90,000	Brush Elecl. Enging. Co., Ord., 1 to 90,000...	S	2½%	...	...	⅞ — 1⅛	⅞ — 1⅛	1⅛	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	£	3 %	...	...	1¼ — 1½	1¼ — 1½	1½	1 3/16
125,000	Do. do. 4½ % Perp. Deb. Stock... ...	Stock	4½%	...	...	109 —112	09 —112	...	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	94 — 98	94 — 98	...	...
9,104	Central London Railway, Ord. Shares	10	...	...	...	9⅜ — 10¼	9½ — 10	10	...
207,649	Do. do. do. £6 paid	10	...	...	...	5⅝ — 6¼	5½ — 6	5⅝	...
630,000	City and South London Railway	Stock	1½%	1 15/16%	1 19/32	58 — 60	59 — 61	60	59
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	*nil*	...	1⅜ — 2¼	1⅜ — 2¼	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	5 %	5 %	...	1⅜ — 2¼	1⅜ — 2¼	2	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5 %	...	3 — 4	3 — 4	...	...
100,000	Do. do. do. 4½% Deb. Stock Red. ..	Stock	4½%	4½%	...	105 —110	105 —110	...	...
110,000	Electric Construction, Ltd., 1 to 110,000	£	*nil*	5 %	...	1½ — 1⅝	1½ — 1⅝	1⅝	1 11/16
12,845	Do. do. 7 % Cum. Pref., 1 to 12,845 ..	£	7 %	7 %	...	2½ — 3	2½ — 3	...	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	£	*nil*	...	...	1 — 1¼	⅞ — 1⅛	1	⅞
69,385	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ..	£	*nil*	...	...	⅝ — ⅝	⅝ — ⅝	...	..
9,600	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ..	10	*nil*	10½%	...	10½ — 11½	10½ — 11½	...	
10,000	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	6 %	8 %	10 %	18½ — 19½	19 — 20	19⅝	19⅛
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ — 19½	18½ — 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	4½%	4½%	109 —114	109 —114	...	...
66,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	...	20½ — 21½	21 — 22	21⅜	21
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	106 —109	106 —109	106½	...
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	2⅞%	...	13½ — 13½	13½ — 13⅜	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	...	16½ — 17	16½ — 17	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	15 %	40 — 43	40 — 43	42	40½
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105	102 —105	...	..
54,000	Waterloo and City Railway, Nos. 1 to 54,000, £8 paid ...	10	...	...	...	9⅜ — 10¼	9⅜ — 10¼	10¼	10⅛

Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.

Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.

CROMPTON & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—6%; 1891—7½%; 1890—8%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

*Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 9.
Electric Construction Corporation, 6 % Debentures, 101—104.
House-to-House Company (£5 paid), 4⅜—5½.
Do. do. 7 % Preference, of £5, 8¾—9½.
Do. do. 4½% Debentures of £100 107—109 xd.
Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 10½—10⅝; 1st Preference Cumulative 6 %, £5 (fully paid), 8—8½.
London Electric Supply Corporation, £5 Ordinary, 1⅜—1⅝.
Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 8½—9. Dividend for 1896—7 %.

* From Birmingham Share List.

Bank rate of discount, 3 per cent. (February 4th 1897).

A FEW PRACTICAL NOTES ON ALTERNATE CURRENT SWITCH-GEAR.*

By L. ANDREWS.

(*Concluded from page* 193.)

I cannot conceive any condition under which this apparatus will cut-out except with a return current, and then it never fails to do so. I have had short circuits on the mains since we have used these switches, but they have not shown any tendency to cut-out. It is, of course, very necessary that the catch supporting the actuating weight should be so designed that it cannot possibly be released by any amount of mechanical vibration. On the other hand, it should be fairly sensitive, or it will require a very large coil to release it, because the series winding must be large enough to carry the full current of the machine for several hours without undue heating, and at the same time there should be enough turns to release the catch with about 25 per cent. of the full output of the machine. Of course, it is possible to use a relay, but relays generally mean complications, which should, I think, be avoided. I have found the catch shown in fig. 1 far more satisfactory than any of the many others we have tried. This is not, as may appear at first sight, merely a long lever doubled back upon itself. If it were, a small increase of pressure on the weight would release it. As it is, no amount of pressure on the lever, L_1, will set it free, because it is so constructed that the arc described by the end of this lever exactly cuts the fulcrum of the lever, L_2. A very slight pull on the end of this second lever will release the weight.

If some magnetic device, such as I have just described, is used, other fuses are not necessary to protect the machines. If they are used they should be heavily fused, at any rate, much more so than any of the circuit fuses.

It appears to me that sufficient attention is not always paid to the prevention of accidents to the attendants in designing high tension switch gear. I think it should be impossible for the most careless man to get injured by a shock; that is to say, there should be no high tension parts exposed anywhere. As far as the machines and connecting wires are concerned, this precaution is usually taken, but on the switch gallery one often sees a large amount of exposed conductors, which it would be extremely uncomfortable to touch. The chief excuse for so much exposed metal is the difficulty experienced in breaking a large high tension current without the aid of a long break. Some engineers prefer to use water to extinguish the arc, and the switches we are now using at Hastings are constructed upon this principle. Although we have had no trouble with them, I must say that I do not like the idea of having water on a switch gallery.

During the past few weeks I have been experimenting with a switch, which, I think, will eventually prove to be in many respects more satisfactory than a water-break switch. The crude idea of this arrangement is shown in fig. 3. This sketch represents a front

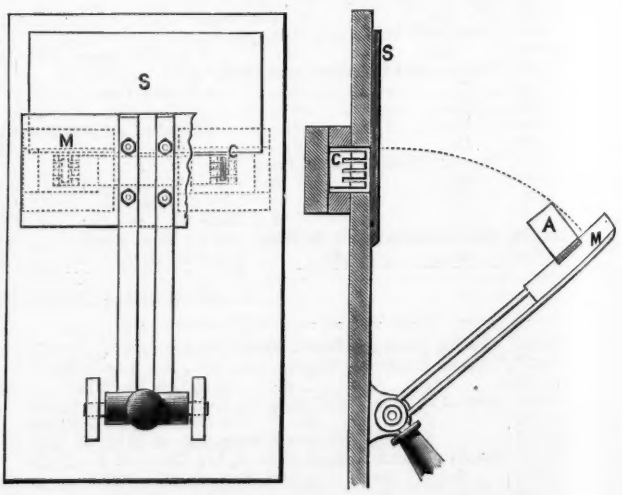


FIG. 3.

elevation of the switch closed, and a side elevation of it opened. The only high tension parts are the contact, C, and the connecting piece, A. It will be seen that these are entirely covered up by the marble slab, M, when the switch is closed, and when it is opened the two contacts, C, which are then the only high tension parts, are covered by the small asbestos shutter, S. This shutter is also used to break the arc, and it does this most effectually.

* Paper read before the Northern Society of Electrical Engineers, January 25th, 1897.

The general arrangement of the switch gear connections is almost as important a factor in the problem of obtaining safe and economical working as the construction of the switches themselves. I think arrangements should be made for running any machines or circuits separate from the common bus bars if necessary. This arrangement is particularly useful in stations where the steam required to run a spare set of plant at full speed is a large proportion of the total steam consumption. For instance, at Hastings last winter, the total output of our station was between 150 and 200 kilowatts for two or three hours every day, and during the whole of this time we had to keep 3·100 unit machines running in parallel to do this work, because if we had depended upon two only, and one of these suddenly broke down, it would have been rather hard on the remaining machine to expect it to take all the work whilst the spare machine was being run up and put into parallel.

If two square bus bars are provided, one for the machines and one for the circuits, then some circuits can be connected directly on to the main bus bar, and others on to the spare circuit bus bar. The latter is coupled to a change-over-switch, by which it can be connected on to the main bus bar, or on to the spare machine bus bar. As a rule it is connected to the former. If one of the machines supplying these two bus bars breaks down, then the spare circuit bar with its load is thrown over to the spare machine bus bar, and at the same time this spare machine is run up to take this load.

At Hastings this change-over-switch is automatically and simultaneously released by switching out the faulty machine. Fig. 4 is a diagrammatic sketch of our high tension connections. The course of the current from the alternators, A_1, A_2, is through the outer conductors to the ammeters, B_1, B_2, and through the fused plugs, F, to the outer bus bar and main ammeter, C. Here it divides itself up, part goes through the circuit fuse plug and ammeter to circuit No. 1, and returns through the inner conductor and the right hand fuse plug direct to the inner bus bar, and the remainder goes through the plug and ammeter to circuit No. 2, and returns through the middle fuse plug to the spare circuit bus bar, and from this to the inner bus bar *viâ* the change-over-switch, G. The spare alternator, A_3, is also connected to the outer bus bar by its fuse plug, and by the middle fuse plug to the spare machine bus bar. If the switchboard attendant finds something going wrong, say with the generator, A_2, he merely closes the small switch, S, which rings the bell, D, thus signalling the driver to immediately run up the spare plant, and as soon as the volts on this machine have reached their normal pressure (or before if necessary), he switches out the faulty machine, A_2. As the weight of this cut-out falls, it completes the battery circuit through the coil, E, thus releasing the change-over-switch, and so taking a portion of the load off the main bus bar at precisely the same moment as the power to supply that load is cut off. Thus the majority of the lamps are quite unaffected, and those that are thrown over to the spare machine only give a slight jump, often unnoticeable.

I have only shown three machines and two circuits on this diagram, but it will be obvious that the same principle can be applied to any number of either. We always arrange our circuits to have about the load of one machine on the spare circuit bus bar. During the few months we have used the arrangement described, we have found it even a greater boon to us than we anticipated. In the first place, if things go radically wrong, as alternating currents have a way of doing occasionally, then it is very essential that the switchboard attendant does not lose his head, and so fail to control the switches in their proper rotation. If, as with us, he only has to control one high tension switch, he cannot go far wrong. Secondly, it enables the station to be worked with a much higher plant load factor. During the last three months of 1896, we generated 11,000 more units than in the corresponding months of 1895. We have nevertheless been able to reduce our cost of coal, oil, waste, and labour for these months from £1,050 in 1895 to £850 in 1896. I must admit, however, that this saving is partly due to the use of a cheaper coal, namely, Llangennech dust. But it may chiefly be attributed to the fact that for several hours each night we now only run two engines, where we used to find it necessary, for safe running, to use three. Thirdly, in the event of a rapid increase of load, such as is caused by a fog, if there is not time to get another machine in parallel, then a portion of the load can be thrown on to the spare machine, and the two bus bars paralleled at leisure. Fourthly, circuit switches are not needed in this arrangement; if a circuit is to be switched off, it is only necessary to plug it on to the spare bus bar, and switch it over on to nothing. Fifthly, if a machine or circuit is known to be faulty, and liable to break down at any moment, it can be run separately, so that its failure will not affect other machines or circuits. Sixthly, all the circuits and machines can be run on the spare bus bars, and the main bus bar left dead for repairs or extensions. It is not necessary to use a separate synchroniser for connecting the main and spare bus bars in parallel, as the main ammeter serves perfectly for this purpose,

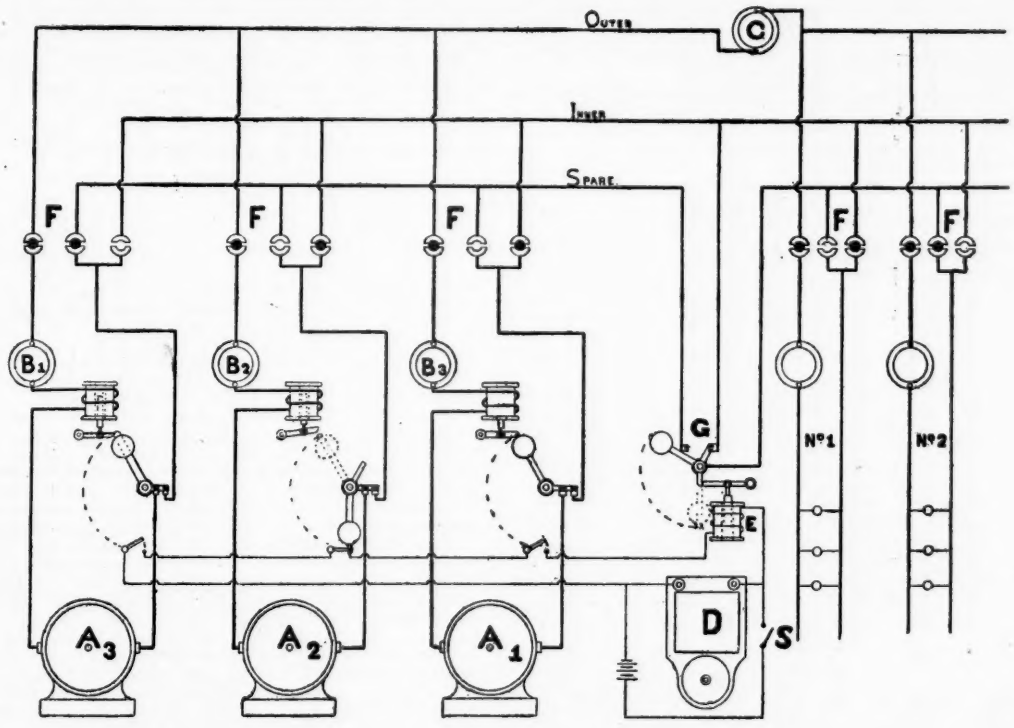


Fig. 4.

because when they are out of phase the ammeter only registers the difference between the amounts of the two currents; when they are in phase it registers the sum of the two.

I think the fields of the alternators should be excited in parallel off an entirely separate exciter, or even preferably off a storage battery. This arrangement greatly simplifies the regulation of pressure. As a matter of fact, we have often found it possible to run for two or three consecutive hours without touching a single regulating resistance, and to maintain during the time a perfectly straight voltmeter curve with three over-loaded Mordey alternators having their fields excited in this way. I should have no hesitation in leaving our switch gallery for an hour without an attendant during the heavy load period, doing all the regulation of pressure by controlling the speed of the engines.

If return current cut-outs are used, there can be no objection to separately fusing the field of each alternator, and I certainly think it is safer to do so, because if the field of one alternator breaks down, it will not then affect other alternators working in parallel with it.

We now only use two alternate current voltmeters in connection with our switch gear; one of these is connected across the secondary of a small transformer on the main bus bars, and the other one is connected to another small transformer, the primary of which can be plugged on to any individual machine or circuit. At one time we used a voltmeter across a single coil of the armature of each machine, but we did not find this arrangement so satisfactory as the present method.

Trouble has sometimes been caused by the synchroniser connections being reversed, either by accident or maliciously. It is often impossible to know from the appearance of a synchroniser which is the right way to connect it up. Report says that when our alternators were run in parallel for the first time at Hastings, Mr. Mordey came down to superintend the operation, and he remarked, before switching in, that he could not tell whether the machines were in phase or out of phase when the lamps burnt brightly, as it entirely depended upon which way the synchroniser was connected up; consequently he should have to switch in on chance. This he then did, and the noise made by the machine made it pretty evident that they were out of phase. This drastic method of testing one's synchroniser connections rather reminds me of the nurse who objected to using a thermometer for testing the temperature of her child's bath, because she could always tell if the water was too hot, as the child then turned red, whereas, if was too cold, it turned blue. For my own part I always prefer to use the following simple method: Before switching an alternator on to the bus bars for the first time, I take out one of the connecting wires from the alternator terminals, thus opening this circuit. I then close the synchroniser switches and the main switches of this machine. This gives the arrangement shown in fig. 5. Now, if the synchroniser is wrongly connected up, the lamps will be extinguished, but if they burn brightly, then we are sure that the connections are right.

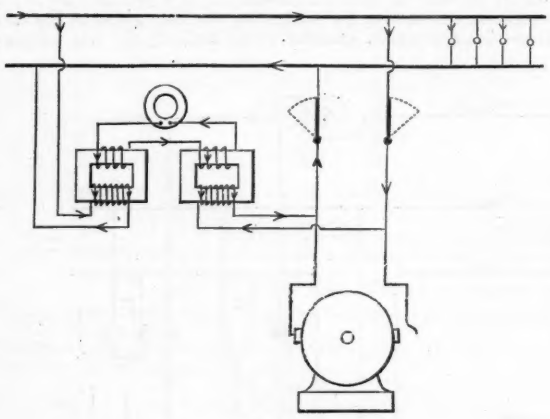


FIG. 5.

I think every switch gallery should have a full-sized diagram of connections painted on the wall above the switch gear. Although we have the one or two devices I have described, which are bound to tend to make our switch gear connections rather more complicated than usual, yet engineers who have never been in the station before are able to trace out every connection by the help of this diagram in a very short time.

We have noticed in using the switch described in the early part of this paper that it never fails to cut-out if a bad synchronise is made, whether the machines are switched in too early or too late, and yet, as I explained just now, the cut-out will only release with a motoring current. This led me to think that we never got a big generating

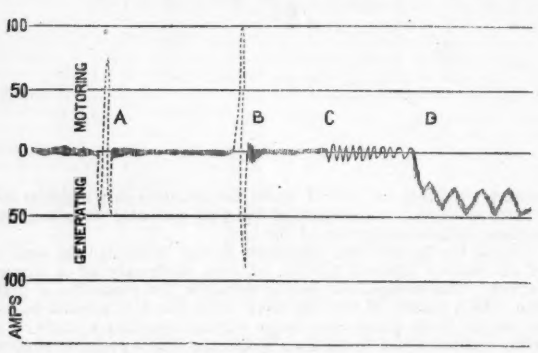


FIG. 6.

current, or it would assuredly cause the machines to roar, and not be cut out. It is only during the past week that I have been able to determine what really occurs. What I have needed for this purpose has been a recording ammeter, which would be practically dead beat, and which would also indicate the direction of the current relatively to the direction of the current in the other machines. I have been able to get this by attaching the flat tape spring of an Ayrton and Perry ammeter on to the core in the solenoid, D_1, fig. 2. The pointer was removed from the Ayrton spring and a small mirror put in its place. A spot of light from an arc lamp in an adjoining room was thrown on to the mirror, and from this it was reflected on to a sheet of rapid bromide paper. This sheet of paper was moved forward at a uniform speed by clockwork. The records obtained by this arrangement are shown in fig. 6. A shows the effect of switching in when the machines were coming into phase, and the synchroniser voltmeter had only risen to about 90 volts instead of 100. It will be seen that we first got a generating current of about 50 amperes, then it reversed, and we got a motoring current of about 75 amperes; this evidently caused the switch to cut out, but before the circuit was interrupted the direction was again reversed to a motoring current. The dotted character of the curve is due to the momentary extinction of the arc at each alternation of the current. This is both interesting and useful, for it enables us to see what time elapsed between the coil releasing the catch and the circuit being interrupted. Each dot represents $\frac{1}{200}$th part of a second, and as there are about 20 dots, it shows that it only took $\frac{1}{10}$th of a second. B shows the effect of switching-in too late, that is, allowing the synchroniser voltmeter to rise to 100, and then letting it drop again to 95 volts. It will be seen that we then started off with a motoring current, instead of a generating current. This immediately caused the cut-out to be released; but before the circuit was interrupted, the direction of the current was again reversed to a generating current. C shows the effect of switching in properly, that is, letting the machines get over the steady phase, and catching a quick phase when the synchroniser volts are on the increase. The machines now drop quietly into step without any perceptible rush of current.

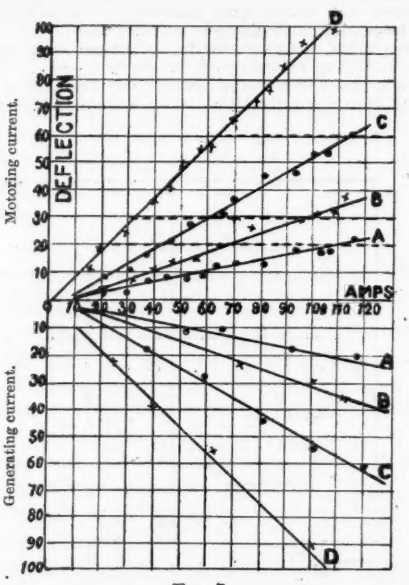


FIG. 7.

I have often been asked if there is any danger of my switch cutting out when there is a lot of synchronising current passing from one machine into another. To ascertain this, I inserted the recording ammeter just described in series with a 50-ampere machine, whose ammeter was fluctuating between 70 amperes and zero. The results obtained are shown at D, fig. 6. I think this curve makes it clear that, however much synchronising current you may get, you do not get a motoring current, consequently the switch will not cut out.

The compound wound coil, D_1, fig. 2, makes an admirable watt indicator. The diagram, fig. 7, shows the deflection you get with varying currents in the series winding, and varying voltages across the shunt winding. The curve, A, represents the deflection obtained with motoring currents in the series winding, varying from 1 to 120 amperes, and with a difference of potential across the shunt of 32 volts. A_1 shows the same deflection is obtained with a generating current, but that it is in an opposite direction. The curves B B_1, C C_1, D D_1, show the deflections obtained with the same currents, but with voltages across the shunt of 36, 55, and 100 respectively. You will see we get a deflection of 20, with 24 amperes and 100 volts = 2,400 watts—or 45 amperes and 55 volts = 2,375 watts—or 67 amperes and 36 volts = 2,420 watts—or 110 amperes and 22 volts = 2,420 watts. Again, we get a deflection of 60 with a current of 63 amperes and 100 volts = 6,300 watts—or with a current of 115 amperes at 55 volts = 6,325 watts. You will also notice that the deflection is directly proportional to the watts; this continues to be so until the core becomes saturated.

ELECTRICITY SUPPLY AT 230 VOLTS.*

BY ALFRED H. GIBBINGS.

THE past 12 months have seen a very marked development in the design, adoption, and popularity of the 200—230 volt incandescent electric lamp. The discussions on Mr. Barnard's paper at the meeting of the Municipal Electrical Association, in June, 1896, and the few actual facts and experiences which Mr. Addenbrook was able to put forward in his paper on "High Voltage Lamps," read before the Institution of Electrical Engineers, in March, 1896, are in themselves quite sufficient to show how little had been accomplished in this

* Paper read before the Northern Society of Electrical Engineers, February 8th, 1897.

direction so recently as 12 months ago. In 1893, while I was at Hull, I experimented somewhat considerably with 220 volt lamps. Although at that time there were not many reliable high voltage lamps in the market, yet I found it convenient to choose the best that could be obtained, and to declare the supply pressure to some consumers on the outlying mains to be 220 volts. These lamps gave so much satisfaction, that upon my removal to Bradford I was encouraged to make a wholesale change of pressure. The results of this, I believe, unprecedented step, I shall endeavour to place before you in this paper.

At this point, however, and before proceeding to details, the following extracts from a speech made by Lord Kelvin so long ago as May 3rd, 1883, may be of more than passing interest. The occasion was a series of lectures delivered at the Institution of Civil Engineers, and speaking of the regulation of pressure, Lord Kelvin said:—

"Supposing, for example (as in the case of my own house, temporarily, until I can get 200 volt lamps) that the proper potential is 84 volts."

And later on, in the same lecture, he says:—

"The domestic incandescent lamp of the early future ought to be, and we hope it will be, a one millimho lamp, to give a 10 or 12 candle light with the Board of Trade regulated 200 volts of potential."

Lord Kelvin also made other references in his lectures in support of the 200-volt lamp.

At the present time I believe that many municipal electrical engineers, and some consulting electrical engineers, are greatly in favour of high voltage lamps, both for alternating and continuous current systems of supply. As examples, I may mention the recommendation by Prof. A. B. W. Kennedy of a three-wire continuous current system, at 460 volts on the outer mains, in connection with the City of York, and also his recommendation of high voltage lamps for Edinburgh.

The instances with reference to alternating current systems are—

1. Cardiff—In which Mr. N. Applebee has recently been purchasing transformers with the intention of supplying at 200 volts.
2. Kingston-on-Thames—The matter is having the consideration of Mr. J. E. Edgcombe this year.
3. Blackpool—Where Mr. R. C. Quin is at present installing 200-volt lamps in place of 100-volt lamps, from the distributing system.
4. Bolton—Mr. Arthur Ellis proposes to introduce the 200-volt lamp in the residential districts.
5. Southport—Mr. Charles D. Taite has decided to supply outlying residential districts at 200 volts, leaving the business portion of the town to be supplied at 100 volts.

The subject of my paper, however, is "Supply at 230 Volts." I wish it, therefore, at the outset to be understood that I consider the question to be of equal importance and interest whatever may be the system of supply, either in vogue or in contemplation, which may be thought most appropriate to any particular district, county borough, or town. Hence I shall confine my remarks chiefly to our experiences with the consumer and the fittings on his premises, and I shall take it for granted that the advantage of supply at 230 volts from a distributing and central station point of view, as far as plant, mains, network, regulation, transformers, public lighting, and economy are concerned, are sufficiently admitted to be beyond dispute.

We have at present about 530 consumers on the mains of the Bradford Corporation Electricity Supply, all of whom are now users of the current at 230 volts. Of these 530 consumers, 500 have been "changed over" from 115 volts since November, 1895, when I first took the management of the department; and it is a significant fact that no solitary instance of supply at 115 volts now remains. Bradford is, therefore, the first town which has completely gone over to the higher pressure.

The following figures give the number of lamps, &c., supplied at the higher voltage, viz., 230 volts, at December 31st, 1896:—

Candle-power.	Number.
8	2,492
16	11,795
25	169
32	1,298
50	167
100	120
150	3
200	32
250	5
300	14

Description.	Number.
Public arc lamps (15 amperes) four in series	8
Private arc lamps (10 amperes) four in series (single carbon)	359
Private arc lamps (5 amperes) two in series (Jandus and other enclosed type arcs)	18
Private arc lamps (5 amperes) two in series (double carbon)	48
Motors—total H.P.—160	71

The equivalent of the above in 8-C.P. lamps at 3·5 watts per candle—49,653.

The amperes demanded are as follows:—

At 115 volts	12,088
At 230 volts	6,044
At 460 volts, three-wire systems	3,022

I have given the above statistics for two very cogent reasons. First, it shows, for both continuous and alternating currents, the immense saving effected in copper, on the three-wire system, over the old methods which were adopted of making the distributing network a simple two-wire system at 115 volts maximum pressure. Secondly, I think you will agree that the experience gained with the actual supply of so many incandescent lamps, arc lamps, and motors over a period of 12 months, at once removes the question as to the practicability, efficiency, and general satisfactoriness of supply at 230 volts in general, and the 230-volt lamp in particular, from a laboratory experiment to that of an accomplished reality.

I now proceed to consider the subject in detail, from the house service terminal boxes to the consumer's lamp, and I will take the opportunity to mention incidentally many little experiences which we have had in effecting the change.

I.—House Terminal Fuse Boxes.

On the table before you lies a sample of the house terminal fuse box, which was originally designed for 115 volts, and which is the universal type adopted in Bradford. For current up to 50 amperes at 230 volts, that is, of course, equal to 100 amperes at 115 volts, we have found the length of fuse amply sufficient, and the insulation equally satisfactory. The covers of these boxes are made entirely separate, instead of being hinged, as in the latter case there is always the liability, through possible contact of one box case with that of another, of getting a spark to earth, and thus damaging the cover. The few older types of fuse boxes which were in use previous to the present design, have been replaced, not only on account of the fuse being too short a break, but for other reasons, irrespective of the alteration in voltage.

The boxes are, of course, single-pole, in order to meet the requirements of the Board of Trade.

II.—Meters.

The types of meters now in use are the Ferranti, the Hookham, and the Thomson-Houston. Previous to these were the Edison electrolytic meter, the Frager, the Aron, and the Oulton-Edmondson, none of which now remain in use. The few remaining pendulum meters which were in circuit at the commencement of 1896 were replaced by those of the motor type, at the time of changing the lamps of the consumers. The motor meters, which were then calibrated at 115 volts, of course, required readjustment. The Ferranti and the Hookham meters, being all direct reading, and simply current meters, were, of course, still available by adopting a constant of 2 as a multiplier. I may here mention that it is now the practice to test every meter for starting current once in three months, and also to take a short test of accuracy of registration at the same time. The Thomson-Houston meters being wattmeters, it was necessary to replace those in use at 115 volts by new meters suitable to the higher pressure. The meters removed were, after recalibration, used for subsequent consumers. The alterations to the Thomson-Houston meters in the readjustment from 115 to 230 volts were as follows:—

1. The resistance of the shunt was increased in the ratio of about 20 to 6, and a portion of the additional windings (about 1,000 turns) was placed inside one of the main coils to act as a starting coil.
2. The number of controlling magnets was reduced from 3 to 2.
3. The dial train was altered to read at twice its previous rate.

With these alterations, the meters started at one-tenth of an ampere, and the consumption of current in the shunt was reduced from about 10 to 6 watts.

The cost of the alterations was about 25s. per meter.

III.—Wiring and Fittings.

It is a peculiar coincidence that Bradford was the first town to own municipally an electricity supply which, as you are all aware, was designed on the simple two-wire system at 115 volts pressure, and that it should also be the first to adopt the 230-volt lamp *in extenso*. Having been started in 1889, and taking over at the same time several installations which had even then been in existence two or three years, it will not be surprising to learn that some antiquated and crude forms of wiring and fittings have had to be dealt with. In fact, I think I may say with every assurance that in no other town will there be found such instances of defective and primitive wiring as we found in Bradford. Fortunately, however, the cases were not numerous. Many of the worst had to be re-wired before my advent, but of those remaining the chief characteristic defect was that the wires were only cotton-covered, and, therefore, dangerous under any circumstances. Notwithstanding the use of cotton-covered wire, we found the insulation tests exceptionally high, as indeed was the insulation of the entire system.

The opportunity afforded in making the change, however, enabled us to call upon these consumers to have their premises re-wired, and when the danger of such inadequate insulation as cotton was pointed out to them, no protest whatever was made. Now, it is just at this point that I wish to state that no additional restrictions or conditions with regard to insulation of wires have been imposed in consequence of the change of voltage, the rules and regulations drawn up for 115-volt supply still being retained. I had ample opportunity of observing the effect of 220 volts on ordinary vulcanised rubber-covered wire and ordinary fittings at Hull and at Bradford, in premises supplied from the outer mains of the three-wire system, and the insulation resistance was invariably maintained in a more perfect condition than was generally found with 115 volts only. This experience has now been verified in a remarkable way, for since all our consumers have been supplied at 230 volts, we have much less leakage in installations particularly and on the whole system generally. The higher pressure, instead of causing unpleasant troubles, has actually freed us from much "earth searching" so frequent in the past, and it appears to maintain the general satisfactoriness of

high insulation. One other slight advantage has been gained. In very large buildings, such as our music halls, markets, Free Library and Art Gallery, hotels, &c., the loss of potential at the furthest lamp has been reduced one-half, and even this loss has less effect upon a 230-volt lamp than upon one of 115 volts. In such buildings and electric light installations the wiring is calculated, more frequently than not, upon current density rather than upon fall of potential. The average provincial wiring contractor thinks he sufficiently and conscientiously complies with the Corporation rules and regulations when he arranges his wiring for a current density not too suspiciously above 1,000 amperes per square inch of section, but he would in many cases look aghast if told that he would only be allowed 1 volt drop at full load at the farthest lamp. In fact, in Bradford, the wiring firms have already shown their appreciation of the lessened amperage per lamp, which admits of cheapened wiring in most cases, but I have found it advisable and necessary to stipulate for fall of potential where the length of wire is considerable.

In respect of fittings, by which I mean switches, fuse fittings, wall plugs, ceiling roses, brackets, pendants, electroliers and lamp-holders, I may say at once, as a general experience, that we have found the more modern type of ordinary 115 volt design equally satisfactory at 230 volts. I have one or two examples of switches, &c., on the table for your inspection, which are not of a modern type, and which I am sure you will agree are better removed than left in under any circumstances. Ceiling roses, switches, wall plugs, and fuse fittings, have here and there required renewal, and have given trouble, but in each instance, fuse fittings excepted, only ordinary good modern types have been used in replacing; in no case has a special fitting been made. Fuse fittings constituted the principal failures under the new supply owing to the usually very short break gap. Smaller sizes were replaced by special types, but the larger sizes were altered *in situ* by the addition of a small bridge of ebonite placed in the gap, thus necessitating the fuse wire being bent around a corner. These alterations were, of course, carried out at the time of changing the lamps in each place, in order not to inconvenience the consumer, and his new lamps usually made ample amends for a little temporary trouble. As a matter of fact, after about 100 consumers were changed, others personally applied at the Town Hall to have the new lamps, and as no public notice had been given of the alterations to be carried out, an impression gained ground, for some reason or other, certain consumers were being highly favoured by the department. This, of course, made matters very smooth, and in no single instance was any opposition offered.

With regard to Ediswan lamp-holders, including those of the switch pattern, not a single one of modern design has been renewed.

It is now about four months since the department has had to attend to any defect in respect of fittings, and these four months have represented the heaviest load in the year.

IV.—Motors.

There are, at present, over 70 electric motors on the Bradford Corporation mains, and of these about 35 have had to be re-wound for 230 volts. The last to be altered was completed on September 24th, 1896, and as the re-winding was placed in the hands of a good firm, and each motor was, on completion, carefully tested for efficiency, speed, and temperature before being replaced, the results have been perfectly satisfactory. Needless to say, that in some instances, old types were improved and errors in design rectified, and much better machines replaced than were taken out. A spare machine was in each case temporarily loaned, and the entire work took about nine months to accomplish. The regulation of motors at 230 volts is better than at 115 volts.

(*To be continued.*)

PROCEEDINGS OF SOCIETIES.

Institution of Electrical Engineers.

Electric Interlocking the Block and Mechanical Signals on Railways. By F. T. Hollins, Member. Paper read January 28th, 1897.

(*Continued from page* 190.)

Diagram fig. 5 shows the arrangement. Sykes's signal reversers are here again made use of. At King's Cross West the lever working the "main," and the "main to goods," advance signals (either signals worked with one lever as geared), is normally electrically locked, such lock being connected with a polarised relay attached to the block instrument. The signals named are fitted with Sykes's reverser, actuated by commutators at the north end of the tunnel. The rails of the down main line through the tunnel are insulated, as a separate section from the adjoining rails, at each end, and at the north end both rails are in circuit with a low resistance and low E.M.F. battery, as shown; and at the south end the circuit is

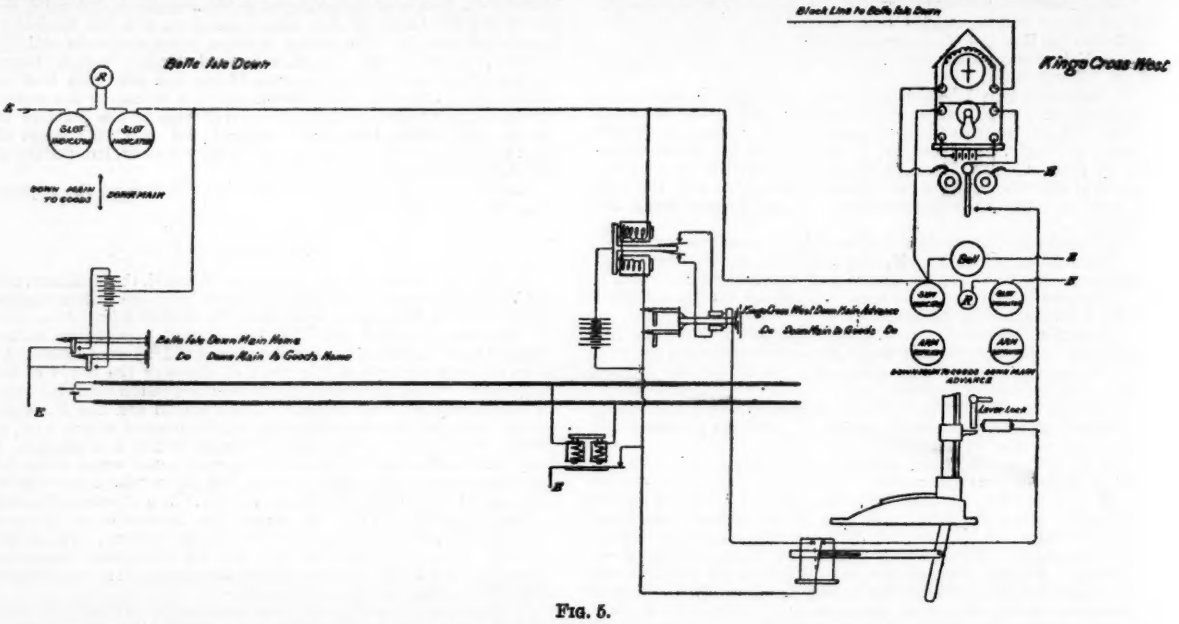
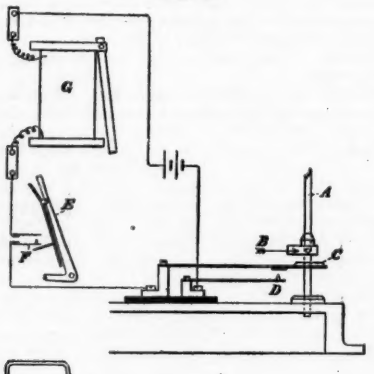


Fig. 5.

completed by a relay, the armature of which forms the earth connection of the lever lock and signal reverser.

Assuming the down main line to be clear through the tunnel, when King's Cross West gives "Be ready" to Belle Isle down

Fig. 6.



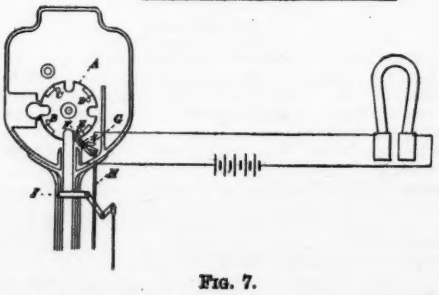


Fig. 7.

(the signal box at the north end of the tunnel), the latter pegs his block instrument to "Line clear;" the polarised relay attached to the block instrument at King's Cross West is actuated, and the lever lock released. Belle Isle next either lowers the "down main" or "main to goods" home signal and the commutatator on such

signal then earths one pole of the battery. The centre of this battery is connected by wire through the tunnel to a polarised relay in connection with the electric slots on King's Cross West down advance signal, one of which is actuated, and admits of the corresponding arm being lowered. On a down train passing into the tunnel, the wheels and axles of the engine short-circuit the battery connected to the rails; the armature of the relay in connection therewith at King's Cross West, being no longer held by the current, moves from the poles of the electro-magnet, and thus disconnects the lever lock and signal reverser circuits, causing the signal arm to go to danger, and the lever lock to fall in position to lock the lever when put back. The contact spring in connection with the signal lever disconnects the lever lock circuit when the lever is pulled over. So long as the engine, therefore, remains on the section of line shown, the signal is locked in the danger position to protect it.

Single Lines.

The traffic capacity of single lines of railway has been so largely increased, and the otherwise unavoidable doubling of such lines for some long time deferred, by the adoption of Tyer's tablet system, and the Webb and Thompson electric train staff, (which is the same thing in another form, but, so far as I can see, minus the block), together with the arrangement for interlocking the same with the signals, that this apparatus is well worth consideration.

Formerly, each section of a line had its exclusive "Train Staff," which delivered into the hands of a driver, was, except the ticket for the *same* direction, the sole authority for entering that section of line.

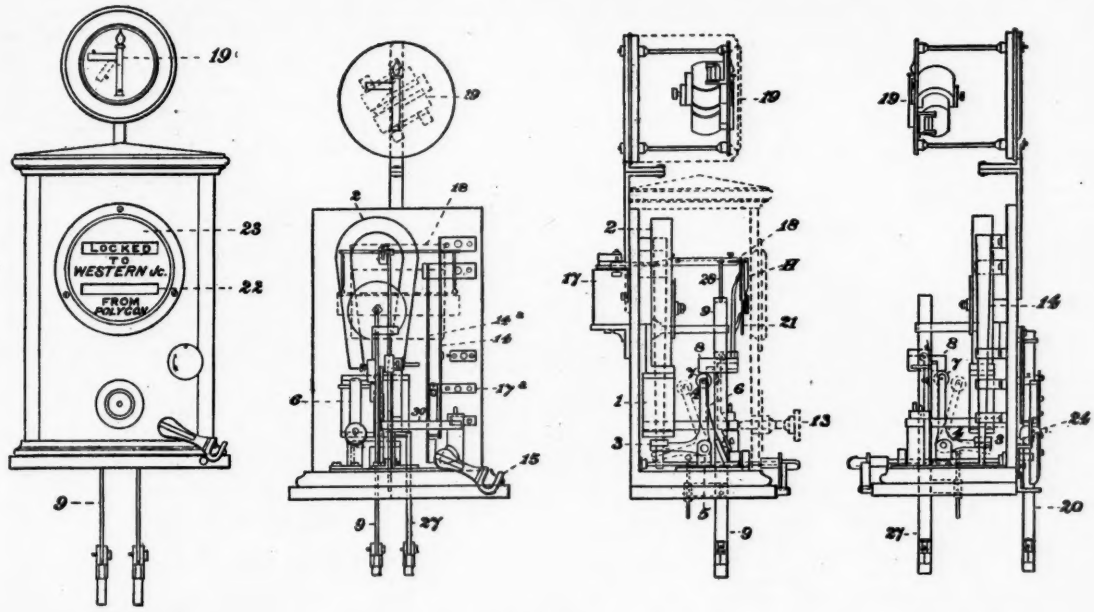
If several trains were known, however, to be passing consecutively in one direction, the person holding the staff could obtain from a box, locked up by the staff, a ticket to give to following trains, and the staff to the last. If the staff happened to be at the opposite end to a train requiring to pass through, there was nothing for it but to send for the staff, and wait.

Tyer's tablet instrument is, so to speak, a combination of the block telegraph and the train staff and ticket, the last two being combined as a metal tablet, controlled by, and its use controlling, the block, the indications of which are given at both ends of the section. A tablet once obtained, the block indications cannot be altered until it is restored to one or other of the instruments controlling the section. Although there may be as many as 30 tablets for the section (half at each end), only one tablet can be obtained at one time; and this requires the concurrent action of both signalmen. But, as a tablet can be obtained at either one end or the other so long as all are in the instruments, there is no avoidable delay in passing trains through the section. The capacity of the line to carry traffic is then only restricted by the length of the section, and the speed of the trains.

Having effectually, and safely, combined the staff, or tablet, always ready at either end of the section, with the block telegraph, it only remained, in order to give the maximum of safety, to electrically interlock this apparatus with the outdoor signals controlling the entrance to the section at both ends to ensure that they could never be contrary the one to the other, and so that the starting signals at each end could never both be off at the same time.

The Tyer's No. 6 tablet instrument is too well known to need description or illustration. Suffice it to say, before obtaining a tablet for a train, the usual "Is line clear?" signal is given on the the bell, to which if clear, the signalman at the other end replies by pressing in the plunger of his tablet instrument to release the opposite end commutator, and the signalman offering the train turns the commutator of his instrument, which also unlocks the drawer, and he obtains the tablet. It is the turning of this commutator in the position to obtain a tablet which also releases, by a momentary current the Sykes's lock on the starting signal. This contact (it is a knuckle-jointed contact) is not made by the back motion of the commutator, but only by the front motion, to obtain the tablet.

Mr. Tyer, however, with his signal lever lock, prefers a constant current, with a key (it may be a lever trigger contact) to close the circuit when the lever is wanted. Fig. 6 shows this. The act of



Figs. 8, 10, 11, and 12.

turning the commutator to obtain a tablet causes the rod, A, to be pressed down, and the pin, B, then presses into contact battery springs, C, D, which, when the trigger of the signal lever, E, is pressed

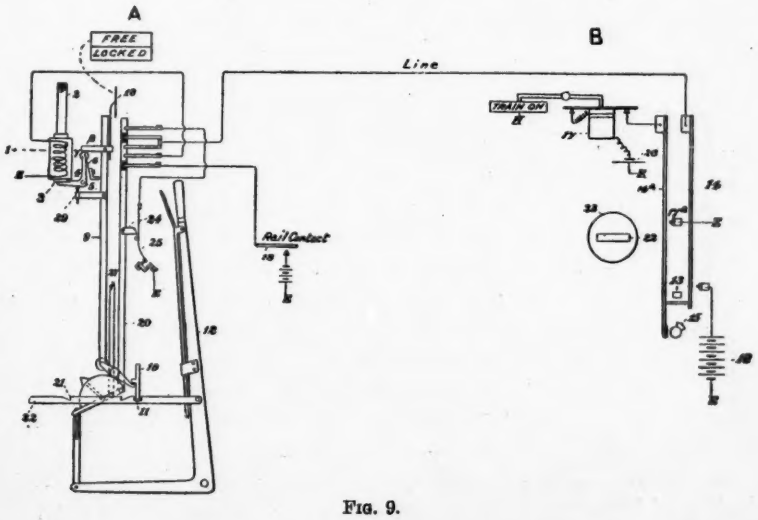


Fig. 9.

to pull over the lever, joins the battery by springs, F, to the lock, G, and thus releases the signal.

As a tablet can only be obtained at one end, the starting signal can only be taken off at that end of the section where the tablet is obtained.

With the Webb and Thompson train staff apparatus the locking is effected by a Sykes locking instrument, applied as shown in fig. 7.

The upper portion of the staff instrument only is shown. The disc, A, is moved round a notch each time a staff is obtained. The small pins, B, C, D, E, on the disc, A, are for the purpose of engaging with the small contact lever, F, as the disc is moved round from right to left in getting out the staff; and this lever, F, then makes contact with G, closing the local circuit, operating the Sykes instrument, and thus unlocking the lever. Putting a staff into the instrument turns the disc from left to right, and this moves the small contact lever, F, in the opposite direction without making contact with G. When, however, the lock has been discharged, and the lever is free, the staff cannot be put in, because the rod, H, would prevent the small contact lever, F, being moved by one of the pins, B, C, D, E, on the disc A. If the starting signal were left off, a staff could not be obtained, as the bolt, I, geared to the signal lever, blocks the passage of the slot in the staff instrument so long as the signal is in the "off" position.

Sykes's Electric Interlocking.

I now come to the description of the system which the directors of the Great Eastern Railway (recognising the rapid growth of their enormous suburban traffic, and being determined to afford every protection that the combination of electrical and mechanical apparatus can give, to safely and expeditiously deal with this traffic), have thought fit to adopt, at a cost of little less than £25,000, over practically the whole of their suburban lines.

Sykes's complete system of double line lock and block requires three line wires, in addition to the wire for the treadle, or rail contact, circuit.

Figs. 8, 10, 11 and 12 show the instrument in the form used upon the Great Eastern Railway for ordinary through working. There are three strong rods (see fig. 9) connecting the locking instrument with the signal lever. One is the actual locking rod; the second is the switch rod, which, by the motions of the lever, connects in one position (signal "On") the *line wire* to the locking coils; and in the other (signal "Off") the *rail contact wire* to the locking coils, and puts the line direct to earth; whilst the third is the rod which actuates the "Train accepted" and "Train on" discs, and prevents plunging to accept another train until the signal lever has been taken off and again put to danger.

Fig. 9 shows diagrammatically the connections between the instrument and the lever, so that the effect of the different motions may be made clear. The electrical connections, minus the semaphore, coil, are also shown, to better illustrate the method of operation.

The locking instrument coils, 1, are fixed upon soft iron prolongations of a powerful compound permanent magnet, 2, and the armature, 3, in the "locked" position (as shown) is held up to the cores of the coils by magnetic attraction. The coils are wound, or the circuit joined up, in such a direction that a strong current from the line neutralises the magnetism induced by the permanent magnet, and the armature, 3 (which forms a portion of an angle piece, 4, with its axis at 5), pressed away from the cores by a strong adjustable "push-off" spring, 6, is discharged, and the small wheel, 7, on the opposite arm of the angle piece, 4, sliding from underneath the catch-piece, 8 (attached to the locking rod, 9), allows the rod to fall, and in doing so it raises the lock, 10, out of the slot, 11, and thus releases the signal lever, 12.

With this diagram, Fig. 9, all the operations may be followed. We will assume that the lever, and the locking instrument (which is really the receiving portion of the apparatus) are at station, "A"; and the plunger, 13, battery spring, 14, switch hook, 15, battery, 16, and "Train on" apparatus, 17 (in a similar complete instrument), are at station, "B," the rail contact, 18, being a train's length ahead of the starting signal at "A."

"A" has a train, and gives the "Is line clear?" signal to station, "B," on the block bell. If the section is clear, and his starting, or section, signal has been put to danger (he cannot do so without), "B" plunges, indicating to himself "Train accepted" by the disc, 21, at the lower aperture, 22, in the screen, 23, and his plunger, 13, becomes locked. This plunge joins the battery, 16, to the line, but without breaking down the "Train on" circuit, the latter, during the act of plunging, getting earth from the stop, 17*a*. The current transmitted releases the lock, 10, at "A" as explained, and indicates by a disc, 18, carried on the rod, 9, "Free." The signalman at "A" then pulls over lever, 12, and lowers his starting signal, and this operation has the effect of raising the locking rod, 9, lowering the switch rod, 20 (figs. 9 and 12), connecting the rail contact circuit to the locking coils, 1, and the line to earth direct. At the same time the lock, 10, has again dropped into another slot, 21, in the tappet, 22, of the lever, back-locking the same in the "off" position, and indicating "Locked" on the instrument.

(To be continued.)

NEW PATENTS.

[Compiled expressly for this journal by **W. P. Thompson & Co.,** *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.]*

1,936. "Improvements in electricity distributing boxes." W. H. Willatt. Dated January 25th. (*Complete.*)

1,964. "Improvements in electric arc lamps." F. Fesquet and J. W. Keys. Dated January 25th.

1,977. "Improvements in underground conduits for electric railways." Z. Goodsell. Dated January 25th.

1,996. "Improvements in electric rollers for therapeutical and massage purposes." J. W. Gibbs. Dated January 25th. [Date applied for under Patents, &c., Act, 1883, Sec. 103, September 22nd, 1896, being date of application in United States.]

2,006. "An invention for utilising the wind pressure on any locomotive, bicycle, carriage, vehicle, or the like, whether driven by manual power (as a bicycle), steam, electricity, water, or the like, using it as a driving or assistant driving power." H. O'Reilly. Dated January 26th.

2,039. "Improvements in electrically-operated gas burners." C. Pettersson. Dated January 26th.

2,082. "Improvements in and relating to electric furnaces." J. Joyce and J. A Deuther. Dated January 26th. (*Complete.*)

2,105. "Improvements in electric meters." The British Thomson-Houston Company, Ltd. (W. C. Fish, United States.) Dated January 26th. (*Complete.*)

2,106. "Improvements in closed conduit electric railways." The British Thomson-Houston Co., Ltd. (E. W. Rice, Junior, United States.) Dated January 26th. (*Complete.*)

2,107. "Improvements in and connected with brake shoes for electric braking apparatus." The British Thomson-Houston Co., Ltd. (F. E. Case, United States.) Dated January 26th. (*Complete.*)

2,125. "New or improved means for economising electric energy in the heating of electrically-heated apparatus and facilitating the use of such apparatus." H. Edmunds. Dated January 26th.

2,140. "The electric self-winding clock." W. Keene. Dated January 27th.

2,152. "Improved method of generating electricity." R. D. Bailey. Dated January 27th.

2,155. "Improvements in the method and means for simultaneous telegraphy and telephony over the same circuit." C. Adams-Randall. Dated January 27th.

2,171. "Improvements in electrical perpetual self-propelling driving systems." W. Clark and C. Clark. Dated January 27th.

2,207. "Improvements in and relating to the decomposition of alkaline salts by electrolysis and in apparatus therefor." J. Greenwood. Dated January 27th.

2,220. "Improvements in electrical heating apparatus." J. B. Verity and H. Russell. Dated January 27th.

2,253. "Improvements in electrical accumulators." A. E. Porte and J. R. Sykes. Dated January 28th.

2,272. "Improvements in or connected with electric batteries." J. L. Dobell. Dated January 28th.

2,275. "Improvements in electric meters." S. L. Tomkins. Dated January 28th.

2,291. "Improvements in insulating frames for electrodes." M. Engl. Dated January 28th.

2,301. "Improvements relating to time meters for telephonic conversations." H. Keim. Dated January 28th.

2,378. "Improvements in and relating to primary batteries." W. Rowbotham. Dated January 29th.

2,412. "An improved method of depositing aluminium by electricity." H. J. Sheldon. Dated January 29th.

2,418. "An improved form of electrode for galvanic secondary batteries." E. W. Bonson. Dated January 29th.

2,445. "An improved thermometric electrical circuit closer." G. H. Zeal. Dated January 29th.

2,447. "Improvements in and relating to accumulators or storage batteries." P. W. Northey and The Epstein Electric Accumulator Co., Ltd. Dated January 29th.

2,462. "Improvements in apparatus for soldering or sealing by electricity in a vacuum or attenuated atmosphere." F. W. Ball. Dated January 29th.

2,470. "Improvements in electroplating apparatus." R. J. Marks. Dated January 29th. (*Complete.*) [Date applied for under Patents, &c., Act, 1883, Sec. 103, October 12th, 1896, being date of application in the United States.]

2,478. "Improvements in electric battery cases to render the contents of the cells unspillable, to facilitate the introduction of the electrolyte into the cells, to enable the level of the liquid to be easily ascertained, and to facilitate inspection of the interior. G. G. Fabbro. Dated January 30th.

2,500. "Improved means for supplying current to electrically propelled railway or tramway vehicles." J. Enright. Dated January 30th.

2,534. "Improvements in or relating to systems of electrical traction." R. Belfield. (G. Westinghouse, United States.) Dated January 30th.

2,536. "Improvements in or relating to galvanometers." F. Brown. Dated January 30th.

2,558. "Measuring apparatus for rotary phase currents." Siemens Bros. & Co., Ltd. (Siemens & Halske, Germany.) Dated January 30th.

2,559. "Method and apparatus for dividing an alternating current into two currents whose phases are shifted relatively to each other more particularly applicable for working or starting single-phase alternate current motors." Siemens Bros. & Co. (Siemens and Halske, Germany.) Dated January 30th.

2,570. "Improvements in or connected with electric cables or conductors." H. Edmunds. Dated January 30th.